



Integrated SCIENCE



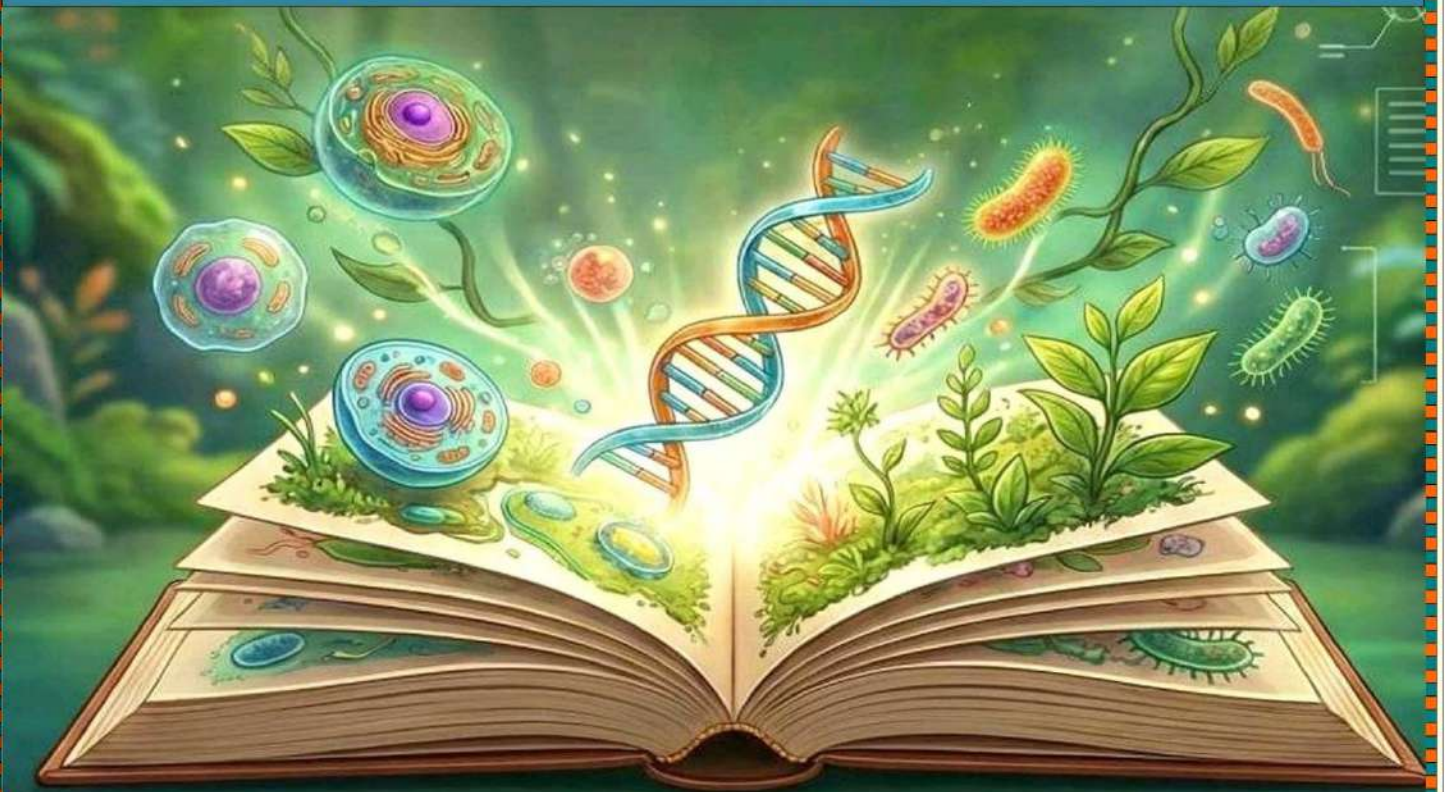
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Geel 2000 Language Schools Sec.(1) Unit (3) Part (1)



Chapter One

Lesson One

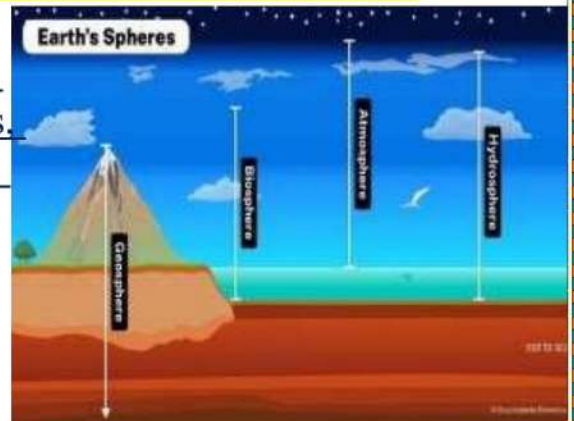
Biosphere

The Biosphere and Its Stability

The biosphere the biosphere is the part of planet Earth where life exists, extending from the depths of the oceans to the mountain tops, passing through the land and air.

The biosphere is a vast, integrated system that includes all living organisms (plants, animals, microorganisms, and all the environments in which they live).

Living organisms in the biosphere constantly interact with their surrounding environment, in a continuous exchange of matter and energy.



The Relationship of the Biosphere to the other spheres

The biosphere is closely linked to the other spheres that make up planet Earth. It does not operate in isolation from them, but rather depends on them for the continuation and balance of life.

The living organisms that make up the biosphere constantly interact with the hydrosphere, which provides them with the water necessary for all vital processes, and with the atmosphere, which provides essential gases such as oxygen, necessary for respiration, and carbon dioxide, necessary for photosynthesis.

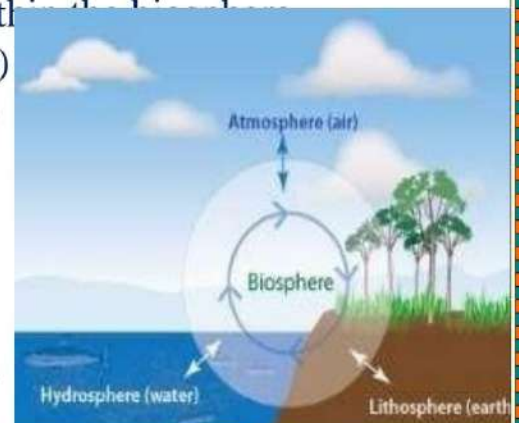
The lithosphere provides mineral elements through the soil upon which plants depend for their growth and stability.

The plant life cycle is a clear example of this interaction.

When a plant absorbs water and salts from the soil (hydrosphere and lithosphere) and **carbon dioxide** from the air (atmosphere), it uses the **sun's energy** to produce food that enables it to grow with

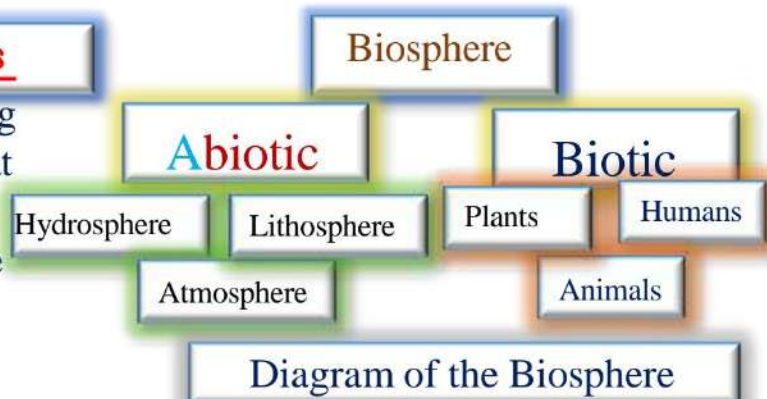
The plant releases oxygen into the air (atmosphere) and returns some of the water to the atmosphere in the form of water vapor (hydrosphere).

When the plant dies, it decomposes in the soil into simpler substances (lithosphere).



Biotic and Abiotic Factors

The biosphere consists of living and non-living components that work together in a balanced system that makes life possible on Earth.



Biotic Factors

These include all living organisms that affect and are affected by the environment, such as plants, animals, and microorganisms.

These organisms play different roles within ecosystems;

A-Plants produce food through photosynthesis and are the primary source of energy for other organisms.

B-Animals are classified as consumers that depend on plants or other animals (prey) for their food.

C- decomposers such as bacteria and fungi break down the remains of dead organisms and return essential materials and elements to the environment for the ecosystem to benefit from again.

Abiotic Factors

are the non-living components of the environment, including light, water, temperature, soil, minerals, and air.

These factors are responsible for determining the type of organisms that can live in a special area, as each living organism needs specific environmental conditions to grow and survive.

Biotic and abiotic factors interact to form a balanced ecosystem that sustains life in the biosphere.

In a lake ecosystem: fish, algae, and bacteria interact with the physical and chemical elements of the water in a continuous cycle of matter and energy exchange.

When several ecosystems share similar climatic characteristics and dominant organisms, **(biome)** For example, the rainforests of the Amazon, Africa, and Asia represent biomes that share a warm, humid climate and abundant biodiversity, while the great deserts share harsh climatic characteristics and drought-adapted plants.



The highest and most comprehensive level is **the biosphere**, the vast system that encompasses all biomes on Earth's surface, including land, water, and air, and contains all life forms and their interactions with the other spheres of planet.

The biosphere extends from the ocean depths to the highest mountains.

Thus, the organization of life progresses in an integrated hierarchy, where the highest level consists of a set of lower levels, linked by complex and reciprocal interactions that ensure the survival of living organisms and the balance of ecosystems on our planet.

Levels of Organization in the Biosphere

Living organisms live within an integrated system; no species can exist in isolation from other species or from its surrounding environment.

Life on Earth is organized in graduated levels of complexity, beginning with the **individual** organism and ending with the largest (**biosphere**), which encompasses all life on planet Earth.

The organism represents the first level of this sequence; 1- single individual of a particular species: like a single fish in a pond or a single tree in a forest.

2-Population: A group of individuals of the same species living in the same place. as antelopes in the African savanna or a group of fish in the waters of the Red Sea

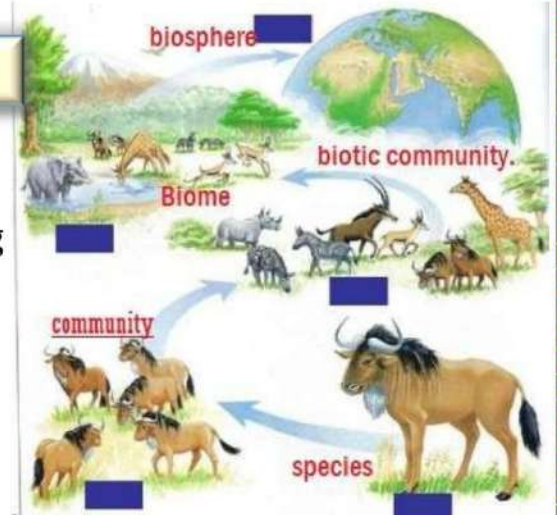
3- Community: a group of different populations living together in one area.

4- Ecosystem: the community and abiotic factors interacting together

5- Biosphere: the largest and most comprehensive level of organization including all biomes on Earth's surfaces such as a forest, which includes trees, herbaceous plants, insects, birds, and mammals, all interacting in a complex network of food relationships.

Food webs the basic mechanisms linking in the levels, which illustrate how organisms obtain matter and energy.

And how each organism obtains its food shows its role within the biotic community and its position in the food web, and demonstrates how energy and nutrients are transferred across the different levels of organization of life.



Feeding patterns and energy transfer in an ecosystem

Food formation in an ecosystem begins with organisms known as autotrophic organisms, or producers.

Producers able to converting inorganic matter into organic compounds (energy-storing). Like green plants and algae, as well as some specialized bacteria.

Plants use light energy, carbon dioxide, and water to make sugars and organic food in the process of photosynthesis, and can express this process simply with the following chemical equation:



Producers form the base of the pyramid (G.R.)? because all the energy comes from their conversion of light energy into usable chemical energy.

Heterotrophic (consumers) cannot produce their own food but obtain it by consuming producers or other consumers



Consumers can be divided

Primary consumers (herbivores)
feed directly on plants

Secondary consumers feed on herbivores
and progress to higher predators

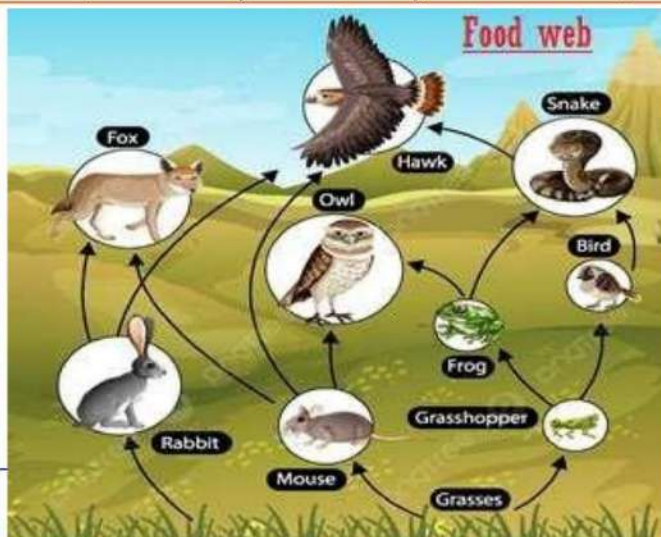
Examples of feeding levels

In the hydrosphere

Microalgae (producers) feed small fish (primary consumers), which in turn feed larger predatory fish (secondary or tertiary consumers).

In the terrestrial system

Trees and plants form a base for rabbits and deer, which are fed by wolves or



Energy Flow in the Ecosystem



Food levels can also be studied through the flow of energy between them.

When a herbivore eats a plant, it obtain only a small part (10%).

Part of the energy transferred to the animal is stored in its cells and tissues.

The remaining energy (90%) does not pass to the next food level.

It is distributed along several pathways, such as:

1. Energy used by the animal in vital processes

The animal uses part of the energy transferred to it from the plant to perform vital processes and activities such as digestion, respiration, movement, and others. These activities consume a large amount of energy.

2- Energy lost as heat

During the animal's activity and its performance of vital processes, a quantity of thermal energy is produced that is transferred to the environment and is not transferred to the organism that feeds on this animal

3- Energy stored in undigested material

Some parts of the plant that the animal eats are not fully digested, such as tough fibers, and therefore the animal excretes some of the stored energy in its wastes



Small part of the energy is transferred to the herbivore.

Small part of the energy is transferred from the herbivore to its predator.

The amount of energy transferred from one trophic level to another decreases as we move up the energy pyramid from producers to consumers.

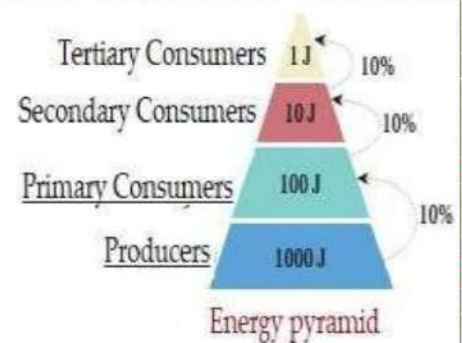
The ecological pyramid models are used to represent the amount of energy, the number of organisms, or their biomass at different trophic levels.

Producers form the base of the pyramid and its largest level, being the most numerous and possessing the greatest amount of energy.

The amount of energy, the number of organisms, or biomass gradually decreases as we move from one level to the next, with the available energy decreasing little by little towards the apex of the pyramid.



The number of organisms at the top of the pyramid decreases (G.R.)? because the available energy only supports a small number of individuals.
the small number of large predators compared to the abundance of plants and herbivores.
 If you have **10,000 energy units** stored in a certain number of plants (producers), only **1,000 units** will reach the herbivores that fed on them (**primary consumers**), then **100 units** to the carnivores that fed on the herbivores (**secondary consumers**), and perhaps only **10 units** to the large predator that fed on the carnivores (**tertiary consumers**).



in desert regions, producers are limited(G.R.)? due to water scarcity and extreme heat. Animals adapt to be energy efficient, food webs are simpler and more dependent on intermittent food sources, and complex food webs also exist, consisting of multiple interconnected chains in which the consumer does not depend on a single food source, but on multiple sources.

This interconnectedness makes a biotic community more resilient to the loss of a single species, but it also makes negative impacts such as deforestation or water pollution far-reaching, as their effects extend throughout the entire network.

Technological Applications

Scientists have developed smart collars with tiny sensors. These are placed around the necks of wild animals in Kenyan nature reserves.

The sensors measure the amount of energy the animal expends each day while it is active and foraging, measuring movement rate, pulse, and body temperature. Using **artificial intelligence**, (Ai) the data is analyzed to determine how much energy the animals are losing.



This innovation helped save endangered herds of Iberian lynx after researchers discovered that declining prey populations had drastically reduced their available energy, enabling reserve experts to intervene and provide a better feeding environment.

Studying feeding patterns is 1- a classification of organisms,
 2- Tool for understanding the dynamics of ecosystems,
 3- How they maintain their balance, or how ecological functions collapse when exposed to disruptive human or natural factors.

Chemical Compounds in the Biosphere

All forms of nutrition in living organisms aim to provide them with the basic chemical compounds upon which life depends.

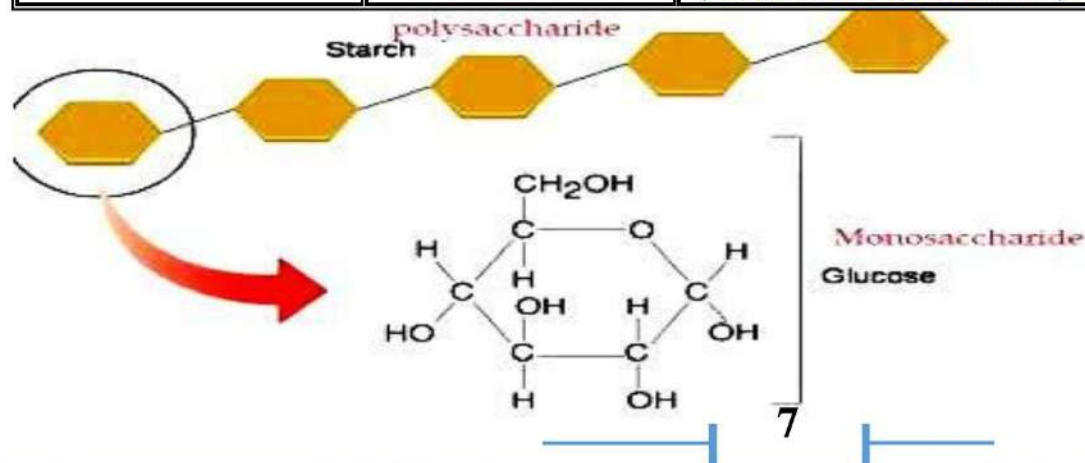
The organic compounds consist of four main groups: (carbohydrates, proteins, lipids, and nucleic acids.) These compounds represent the sources in which energy is stored and the elements that regulate vital processes. Below, we will learn about the most important of these compounds, their structure, and their vital functions.

Fist: Carbohydrates: The Main Source of Energy

Carbohydrates are the most common organic compounds in living organisms, Carbohydrates molecules consist of carbon, hydrogen, and oxygen in ratio of (1:2:1) respectively. They are the main source of energy in most living organisms, as these compounds are broken down in cells to produce the energy necessary for vital activities.

Carbohydrates are divided into three main types

Monosaccharides	Disaccharides	Polysaccharides
the simplest form of carbohydrates	Made of two monosaccharide	complex compounds made up of many monosaccharides
Used directly in cellular respiration to produce energy, such as <u>glucose</u> (Grape sugar) and <u>fructose</u> (fruit sugar).	such as sucrose (cane sugar) and <u>lactose</u> (milk sugar)	They are involved in cell building, energy storage, or the formation of <u>supporting structures</u> , such as <u>1-cellulose</u> , which is part of plant <u>cell walls</u> <u>2-chitin</u> , which is part of the <u>exoskeletons of arthropods</u> ; <u>3-starch</u> , which is stored in plants (in <u>leaves</u> and <u>tubers</u>); <u>4-glycogen</u> , which is stored in animals (in the <u>liver</u> and <u>muscles</u>).



Energy in Living Cells

Adenosine triphosphate (ATP) molecules are the direct source of energy in living cells. They represent a form of chemical energy that can be used directly in various vital processes.

ATP (adenosine triphosphate) consists of

1- three phosphate groups

2- molecule adenosine.

The bond between the second and third phosphate groups is high-energy (G.R.?) because it requires a large amount of energy to form.

When this bond breaks, a quantity of energy is released that the cell can directly utilize in performing its vital functions, such as muscle contraction or transporting materials across membranes.

When glucose, produced by photosynthesis or derived from food in heterotrophic organisms, enters the cell, it is broken down in a series of chemical reactions known as cellular respiration.

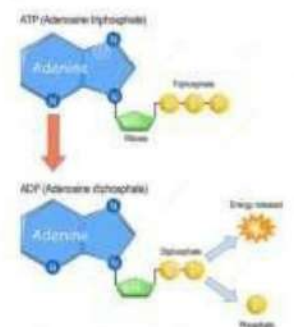
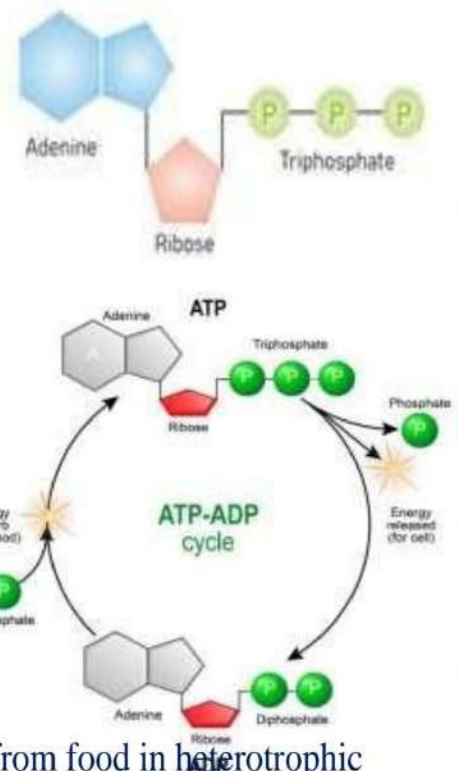
During this process, its chemical bonds are gradually broken, releasing energy. This energy is not used directly but is stored in ATP molecules.

When a cell needs energy, this bond breaks, converting ATP molecules into Adenosine diphosphate (ADP). This releases the energy needed for the cell to perform its functions, such as muscle contraction, transporting materials across membranes, or building biomolecules.

By adding a new phosphate group, the cell can regenerate an active ATP molecule from ADP, using some of the energy produced from the oxidation of glucose to ATP. This continues the delicate biological cycle that ensures cells have a continuous and renewable energy supply to sustain life.

تُعد أجهزة مراقبة الجلوكوز المستمرة

Continuous glucose monitoring (CGM) devices are among the most important modern health innovations. They measure blood sugar levels inside the body every few minutes without pricking, helping to track the availability of carbohydrates as an energy source before they are converted into ATP molecules



These devices help patients and athletes understand the impact of carbohydrate meals on energy production and adjust their eating patterns and physical exertion levels accurately to maintain stable energy and better health.



Second: Proteins: Functional building blocks in living organisms within the biosphere

Proteins are large, **complex molecules** made up of **amino acids**. These molecules contain the elements **carbon**, **hydrogen**, **oxygen**, and **nitrogen**, and sometimes **sulfur**. **They constitute the main building unit** in the bodies and in the structure of **muscles**, **enzymes**, some **hormones**, and **antibodies**.

Proteins differ according to the **arrangement of amino acids** within their chains, and this arrangement determines their shape and function.

For example, structural proteins such as keratin give strength to hair and nails, while enzymatic proteins such as amylase act as catalysts that accelerate the rate of biochemical reactions within the body without being consumed in the process. When proteins are broken down during digestion, they are converted into amino acids that are reused to build new proteins according to the needs of the cells.

Third: Lipids: Energy Stores

Lipids are organic compounds whose molecules are mainly composed of **carbon**, **hydrogen**, and **oxygen**.

They are a concentrated source of energy in the body, **producing twice the energy of carbohydrates when oxidized**.

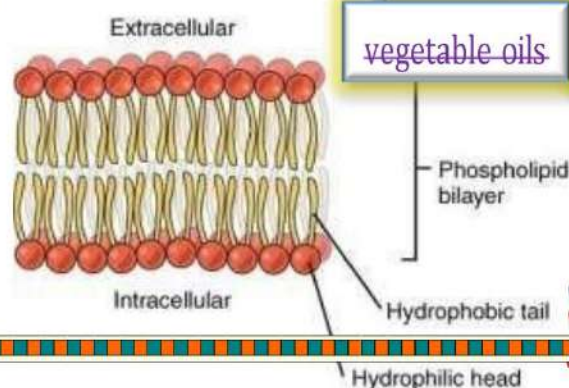
They also act as thermal insulation, maintaining body temperature, such as the thick layer of fat in a **polar bear**.



Phospholipids are fatty molecules containing a **phosphate group** and are an essential part of **cell membrane structure**, forming a double layer surrounding the cell.

fats stored in **fatty tissue** for use by cells when energy is needed.

Some types of fats, such as **cholesterol**, are involved in the formation of certain **hormones** and **vitamin D**.



Forms of fats—

vegetable oils

animal fats

ted
NCE

Hydrophilic head

Comparing the heat content of Fats and Carbohydrates.

Heat content is the amount of heat produced by burning one gram of food. Its unit kilojoules per gram (kJ/g).

In practice, the adult unit kcal/g is usually used, (1 Calorie =4.18)

Practical Experiment

Tools:

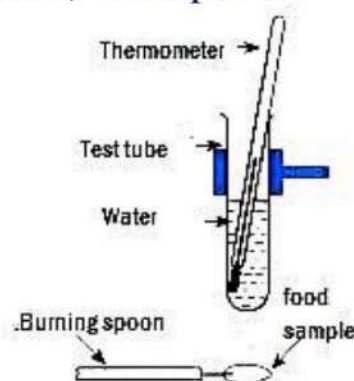
Test tube - Combustion spoon - Bunsen burner - Sensitive balance - Thermometer - Water - Sample of white sugar (carbohydrate) - Sample of pure vegetable oil (fat).

Steps

- 1- Place a suitable volume of water in the test tube.
- 2-Record the initial water temperature (t_1) using the thermometer.
- 3-Place a certain mass of sugar (108) in the combustion spoon
- 4-Begin burning the food sample using a Bunsen burner flame 1 cm from the test tube until completely burned.
- 5-Record the final temperature of the water (t_2).

The change in temperature of the water sample (t_1 - t_2) represents the amount of energy gained by the water and the test tube, which in turn represents the amount of energy released from the food sample when it is deflected.

- 6-Repeat the previous steps with a similar mass of cooking oil.



Record your observations

Conclusion:

Modern Technology and the interpretation of biomolecule structure from a physical perspective

Modern technology has led to the development of precise instruments that have enabled scientists to study the basic compounds of life at the molecular level. the most important of these instruments is the electron microscope, which relies on the use of a beam of electrons instead of light to form an image. The wavelength accompanying the electron can be controlled to be much shorter than the wavelength of light,



allowing the visualization of very small structures such as membrane proteins and lipids that cannot be seen with conventional light microscopes.

This advance has helped in understanding how molecules are arranged within cells.

Especially plasma membrane that are built from double layer of lipids, which has contributed to the design of modern drugs that target specific proteins inside the cell between foods.

the extent of integration between different branches of science in producing modern materials and tools that improve the quality of life and maintain balance on planet Earth.

Fourth: Nucleic Acids:

Ensuring the Continuity of Life in the Biosphere

Nucleic acids are the basis of heredity in all living organisms.

They carry the genetic code responsible for determining the organism's characteristics and regulating the functions of its cells

Nucleic acids are made up of small units (nucleotides) each consisting of a five-carbon sugar, a phosphate group, and a nitrogenous base.

The nitrogenous bases are adenine (A), thymine (T), cytosine (C), and guanine (G).

The arrangement of these bases creates what is known as the genetic code, which determines all the characteristics of an organism.

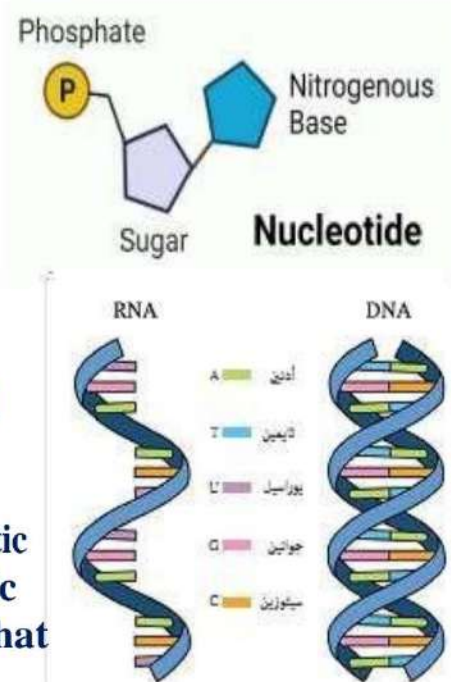
There are two main types of nucleic acids.

Deoxyribonucleic acid (DNA), which carries the genetic information within the cell nucleus of eukaryotic organisms and carries the genetic information that is passed from generation to generation

Ribonucleic acid (RNA), which is involved in converting this genetic information into proteins that carry out the cell's functions.

Modern Technological Applications

In modern laboratories, **CRISPR-Cas9** technology is one of the latest genetic engineering tools used to edit DNA.



Scientists use this system as a high-precision molecular scissors to target a specific sequence of nitrogenous bases (adenine, thiamine, cytosine, and guanine) within the cell genome (the complete set of genetic information in an organism). This extreme precision allows for specific gene editing for the purpose of correcting defective or disease-causing genes, such as those that cause sickle cell anemia adding new genes or removing unwanted genes to produce crops with improved characteristics and disease resistance.



Chapter One (I) Lesson (1)



Choose the correct answer:

1. The part of Earth where life exists is called the:
A) Atmosphere B) Lithosphere C) Hydrosphere D) Biosphere
2. The biosphere extends from:
A) Earth's surface only B) Mountain peaks only
C) Ocean depths only D) Ocean depths to mountain peaks
3. The sphere that provides water for living organisms is the:
A) Atmosphere B) Lithosphere C) Hydrosphere D) Biosphere
4. The gas necessary for respiration is:
A) Nitrogen B) Oxygen C) Carbon dioxide D) Hydrogen
5. The gas necessary for photosynthesis is:
A) Oxygen B) Nitrogen C) Carbon dioxide D) Helium
6. Soil and minerals belong to the:
A) Atmosphere B) Hydrosphere C) Lithosphere D) Biosphere
7. Plants in a food chain are classified as:
A) Consumers B) Decomposers C) Predators D) Producers
8. Animals that feed on plants or other animals are called:
A) Producers B) Consumers C) Decomposers D) Autotrophs
9. Bacteria and fungi are examples of:
A) Producers B) Consumers C) Decomposers D) Predators
10. Light, temperature, and water are examples of:
A) Biotic factors B) Producers C) Consumers D) Abiotic factors
11. The interaction between living and non-living components forms a(n):
A) Population B) Community C) Ecosystem D) Biome
12. A group of organisms of the same species living together is called a:
A) Community B) Population C) Ecosystem D) Biome
13. A group of different species living in one area is called a:
A) Population B) Community C) Biome D) Biosphere
14. A group of ecosystems with similar climate is called a:
A) Biosphere B) Ecosystem C) Biome D) Population
15. The largest level of organization of life is the:
A) Ecosystem B) Biome C) Community D) Biosphere
16. The smallest level of organization is the:
A) Population B) Community C) Organism D) Ecosystem
17. Food webs show:
A) Shape of organisms B) Number of organisms
C) Transfer of energy and matter D) Habitat only
18. Producers make their food by:
A) Respiration B) Digestion C) Fermentation D) Photosynthesis
19. The main source of energy in ecosystems is the:
A) Water B) Soil C) Sun D) Oxygen

20. The approximate percentage of energy transferred to the next trophic level is:

- A) 90% B) 50% C) 10% D) 100%

21. Most energy is lost from organisms as:

- A) Food B) Light C) Heat D) Matter

22. The base of the energy pyramid consists of:

- A) Carnivores B) Herbivores C) Decomposers D) Producers

23. The number of organisms decreases toward the top of the pyramid because of:

- A) More food B) Less available energy C) More oxygen D) Higher temperature

24. Producers are limited in deserts because of:

- A) Heavy rain B) Water scarcity C) Fertile soil D) Low temperature

25. The chemical formula of glucose is:

- A) CO_2 B) H_2O C) $\text{C}_6\text{H}_{12}\text{O}_6$ D) O_2

26. The direct source of energy in cells is:

- A) Glucose B) ADP C) ATP D) DNA

27. ATP consists of:

- A) Sugar only B) Bases only C) Adenosine and three phosphate groups D) Lipids

28. Energy is released when:

- A) ATP is formed B) A phosphate bond is broken C) DNA is copied D) Oxygen is used

29. Cellular respiration occurs in the:

- A) Nucleus B) Ribosomes C) Chloroplasts D) Mitochondria

30. Carbohydrates contain carbon, hydrogen, and oxygen in the ratio:

- A) 2:1:1 B) 1:2:1 C) 1:1:2 D) 2:2:1

31. The simplest carbohydrates are:

- A) Disaccharides B) Polysaccharides C) Monosaccharides D) Starch

32. Starch is stored in:

- A) Animals B) Plants C) Bacteria D) Fungi

33. Glycogen is stored in:

- A) Plants B) Leaves C) Animals D) Wood

34. Proteins are made of units called:

- A) Fatty acids B) Nucleotides C) Sugars D) Amino acids

35. Enzymes are classified as:

- A) Lipids B) Carbohydrates C) Proteins D) Nucleic acids

36. Lipids provide:

- A) Less energy than carbohydrates B) Equal energy C) Twice the energy D) No energy

37. The plasma membrane is mainly composed of:

- A) Proteins only B) A phospholipid bilayer C) Carbohydrates D) Chitin

38. The molecule that carries genetic information is:

- A) RNA B) Protein C) DNA D) ATP

39. Which is NOT a nitrogenous base?

- A) Adenine B) Guanine C) Cytosine D) Glucose

40. The modern gene-editing technology is:

- A) PCR B) Cloning C) DNA fingerprinting D) CRISPR-Cas9

Second: Give reason for

1. Plants form the base of the energy pyramid.
2. Energy decreases at higher trophic levels.
3. Living organisms cannot live in isolation
4. Decomposers are essential in ecosystems.
5. Deserts have few producers.
6. ATP is called the energy currency of the cell.
7. Lipids are an efficient energy source.
8. Proteins are important for the body.
9. DNA is essential for living organisms.
10. Food web complexity increases ecosystem stability.



Model answer

First: Choose the Correct Answer

1. D 2-D 3-C 4-B 5-C 6-C 7-D 8-B 9-C 10-D 11-C 12-B 13-B
14-C 15-D 16- C 17-C 18-D 19-C 20-C 21-C 22-D 23-B 24-B 25-C 26-C
27-C 28-B 29-D 30-B 31-C 32- B 33-C 34-D 35-C 36-C 37-B 38-C 39-D 40-D

Second: Give reason for

- 1- Because they convert solar energy into chemical energy.
- 2- Because most energy is lost as heat and in life processes.
- 3- Because they depend on biotic and abiotic factors.
- 4- Because they recycle nutrients back to the environment.
- 5- Due to water scarcity and extreme heat.
- 6- Because it provides energy directly for cellular activities.
- 7- Because they release more energy than carbohydrates.
- 8- Because they build tissues and act as enzymes.
- 9- Because it carries hereditary information.
- 10- Because organisms depend on multiple food sources.



Lesson Two Vital processes in living organisms and the stability of the biosphere

Living organisms need a delicate system that ensures the movement of essential materials within them, such as water, salts, oxygen, and nutrients. Transport, respiration, and excretion are among the most important vital processes that maintain this balance.

Transport provides each cell with the materials it needs, while respiration converts the energy stored in those materials into energy used to perform various vital activities. In excretion, the organism gets rid of waste products resulting from vital processes.

Through this integration, living organisms contribute to the stability and balance of the biosphere, recycling materials and energy in a way that sustain...

First: Transport in Living Organisms and its Role in the Distribution of Materials and Energy

1. 1. Vascular vessels in plants

a- Higher plants possess transport systems that enable them to move water, salts, and manufactured nutrients within their vascular tissues, although they lack a specialized organ to propel them like the heart in humans. These systems are the xylem and phloem tissues:

Xylem tissue Transporting some raw materials for the photosynthesis process

absorbed mineral salts from the soil to the leaves, where photosynthesis takes place.

Structure **xylem tissue**,

A- Tracheids: hollow tubes extending from the roots to the leaves, which are dead cells in the mature plant to facilitate water passage.

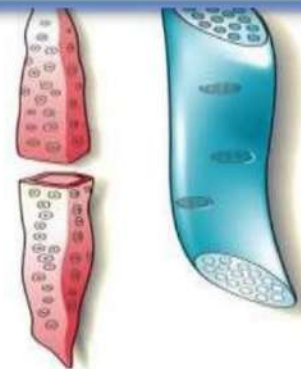
The walls of the xylem vessels are supported by a hard substance (lignin.)

Lignin a substance that gives the vessels:

A- Strength and rigidity and prevents their collapse

B- Helps resist compression,

C- Allowing the vessels to maintain their shape even in the tallest plants



Tracheid

Water and mineral salts move through the xylem vessels in one direction, from the roots to the leaves, relying on the unique physical properties of water molecules.

In the xylem vessels, water moves in a continuous column from the root to the top of the plant.

Explains how water rises against gravity.

The theory of cohesion and adhesion

Cohesion and Adhesion Theory:

This theory is based on three types of fundamental forces:

1. Cohesive forces: These are the forces that bind water molecules together due to hydrogen bonds, keeping the water column in the wooden vessels cohesive as it moves.

2. Adhesive forces: the attractive forces between water molecules and the walls of the wooden vessels, helping to stabilize the water column as it rises.

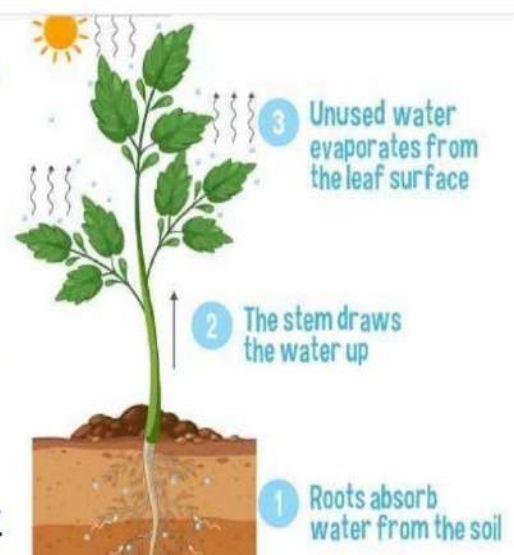
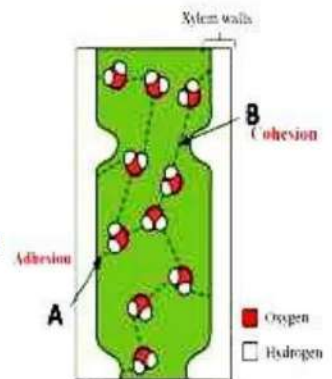
3. Transpiration Pull: The loss of water vapor from leaves through the stomata during transpiration reduces the number of water molecules in the leaf cells. This causes the water pressure in the leaf to become lower than that in the stem or root, i.e., negative. This creates a pulling force known as "transpiration," which pulls the column of water connected in the xylem vessels upwards.

N.B ;

Water and mineral salts move continuously from the root to the stem and leaves. Therefore, a tall plant like a pine tree can lift water tens of meters without a pump.

The role of the transpiration process

- 1- Getting rid of excess water or regulating the temperature of the plant,
- 2- It also contributes to adding water vapor to the atmosphere,
- 3- Contributes to the formation of clouds and rainfall as part of the water cycle in nature.



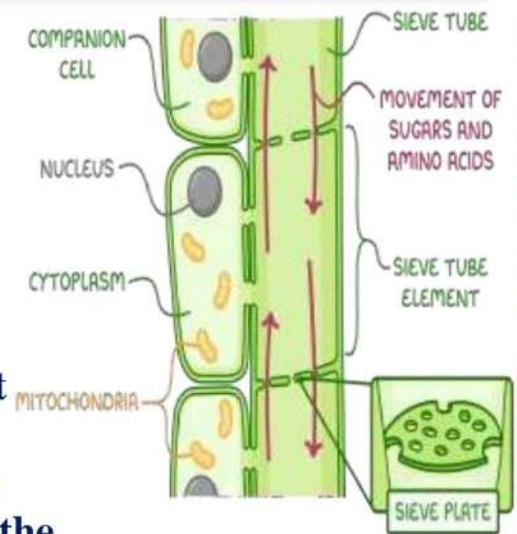
Phloem tissues Transporting the products of photosynthesis as an energy source in the biosphere process

Phloem tissue : transports the products of photosynthesis, (glucose - amino acids) from the leaves to all parts of the plant, including roots, fruits, and seeds.

Structure phloem tissue,

1- **Sieve tubes** interconnected living cells known as, which are lined up side by side to form interconnected transport channels.

-Sieve tube cells do not contain a nucleus, but
2- **Companion cells** associated Sieve tubes that supply them with energy and help them regulate the movement of nutrients through the phloem.



This transport occurs in two directions, upwards and downwards, according to the plant's needs at each stage of growth.

Sugars are stored in the roots during the winter and then transported back to the leaves in the spring to nourish new growth.

The plants an efficient and balanced system for distributing water and energy that ensures their continued life and growth

Modern technological applications

Studying fluid movement in plants

1- Micro-CT scanning, are used to study the complex mechanisms of water and nutrient transport within the plant with high precision, specifically in the xylem and phloem tissues

2- This technique creates three-dimensional (3D) images of vascular structures, xylem and phloem tissues without destroying the plant specimen.

3- These images allow us to monitor the movement of water through xylem vessels and to check phenomena inside the vessels, such as the formation of air bubbles that impede the continuous upward movement of the water column against gravity.

4- These experiments and applications help to understand the role of cohesion and adhesion in the uplift of water to the tops of trees, providing information for developing drought resistance strategies and improving water use efficiency in agriculture.



2: The circulatory system in humans and its role in the transport process

Internal transport system

to ensure that oxygen and nutrients reach all the body's cells.

The circulatory system performs this vital role through an integrated network it consisting of (heart, blood vessels - blood.)

The heart

It acts as a powerful muscular pump, propelling blood through two main, complementary cycles.

1-Systemic Circulation

Blood rich Oxygen is pumped from the left ventricle through the aorta to all body tissues, while oxygen-poor, carbon dioxide-rich blood returns through the veins to the right atrium, then to the right ventricle.

2-Pulmonary circulation

oxygenated blood is pumped from the right ventricle to the lungs to supply the red blood cells with oxygen from inhaled air and release carbon dioxide to be expelled from the body with exhaled air. Then the oxygenated blood returns to the left atrium, and then to the left ventricle.

Blood vessels

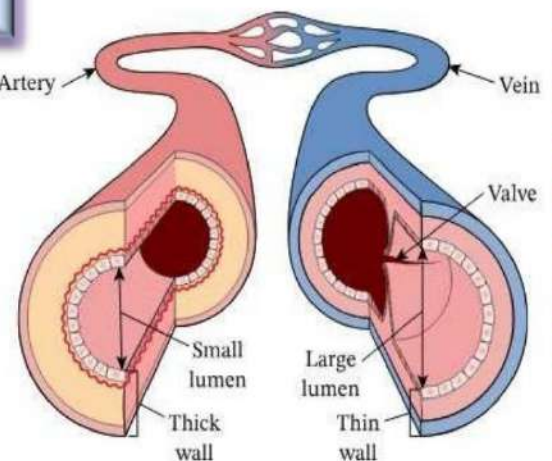
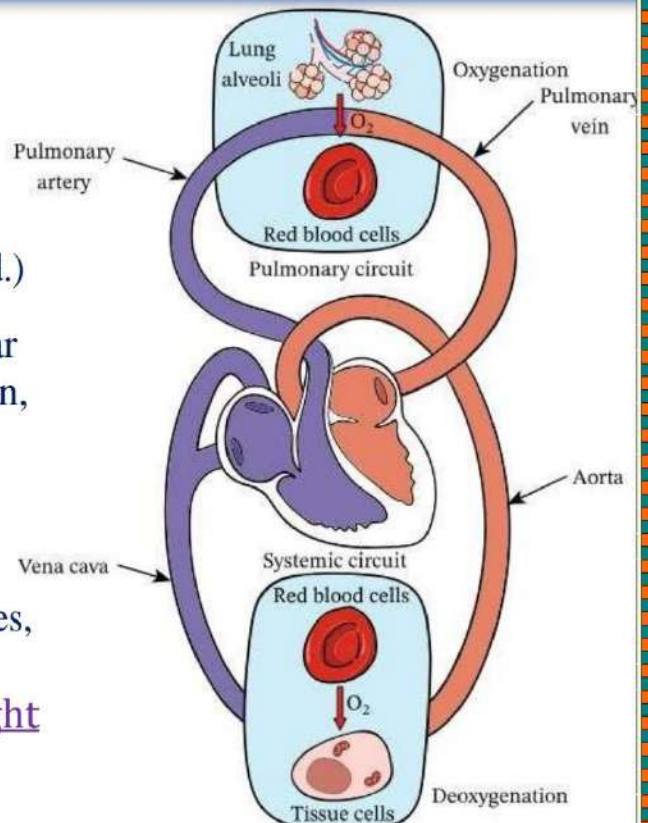
Blood vessels are networks for transporting energy and vital substances within a living

organism, and are divided into:

a-Arteries transport oxygenated blood at high speed and pressure from the heart to different parts of the body.

B-Veins return deoxygenated blood from the body to the heart at low pressure, with the help of valves that prevent backflow within the vein.

c- Blood capillaries The actual exchange of substances, such as oxygen, carbon dioxide, glucose, and waste products, between the blood and the body's cells takes place in the capillaries



Circulatory system is integrated with the respiratory system, which supplies the blood with oxygen, and the excretory system, which get rid waste.

During physical exertion, the respiratory and heart rates increase respiratory rate to provide the muscles with more oxygen and energy, and the rate (getting rid sweat) also increases. This is a simple example of homeostasis in the body's functioning.

Blood pressure in humans

The heart pumps blood by the vital driving force that ensures oxygen and nutrients reach all cells and tissues.

As blood circulates throughout the body, it exerts pressure on the walls of blood vessels (arteries and veins).

This pressure is essential for continuous blood flow and is typically measured as one of two values:



1-Systolic pressure	2-Diastolic pressure
Its normal value is 120 mmHg	Its normal value is= 80 mmHg
This is the <u>top value of blood pressure</u> and represents the <u>maximum force exerted by the blood</u> on the artery walls during the heart's <u>contraction</u> to pump blood to the body.	This is the <u>bottom value of blood pressure</u> and represents the <u>minimum force exerted by the blood</u> on the artery walls during the heart's <u>relaxation</u> .

Blood pressure measurement

The mercury sphygmomanometer is the most common device for measuring blood pressure, but digital alternatives are now widely available.



Physical properties of blood and maintaining normal blood pressure

The blood : fluid maintains blood pressure

at its normal level.

Its importance:

1-Viscosity: Blood is a viscous fluid (more viscous than water)

G.R.? because it contains red blood cells,

white blood cells, platelets, and dissolved proteins

of red blood cells), resistance to flow increases, causing pressure increases.

3- if viscosity decreases, blood flows more easily, and blood pressure decreases.



2-Blood density, changing by change the proportions of its components (especially hemoglobin), affects the effort required to pump blood.

The elasticity of blood vessel walls during contraction and relaxation, and the force of the heart's pumping action, and affect the vital pressure.

Modern physical applications for treating high blood pressure:

RENAL DENERVATION

Renal denervation is one of the latest techniques that helps stabilize blood pressure in patients who do not respond to medication.



This technique is a simple, non-surgical medical intervention that uses high-frequency radiofrequency energy or ultrasound to inhibit or disable the active nerves around the kidney that send nerve signals leading to excessively high blood pressure.

Thus, advanced physical applications can contribute to protecting human health and supporting stability within the biosphere.

Second: Breathing and obtaining energy

Cellular Respiration

Every cell in a living organism needs a energy to carry out its vital activities, from transporting materials across membranes to division and growth.

Cells obtain this energy from the process of cellular respiration

Cellular Respiration

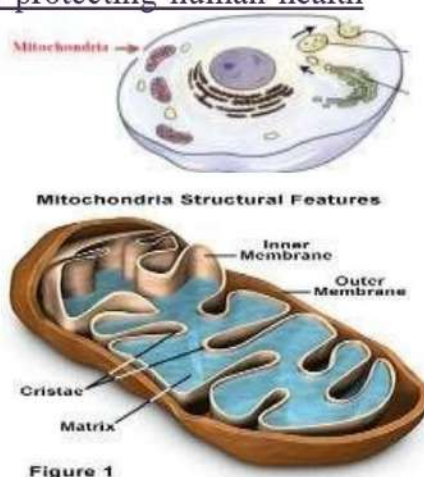
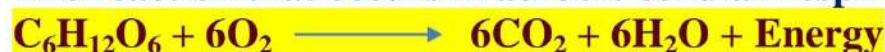
It is a series of chemical reactions that release the chemical energy stored in glucose and store it as usable energy in the form of **ATP**

Steps of cellular respiration:

1- Glycolysis the 1st stage in the cytoplasm where one glucose molecule is broken down and a small amount of energy is produced in the ATP molecules.

Aerobic respiration takes place in the presence of oxygen in the **mitochondria** "**powerhouses**" of the cells, producing CO₂, water and a large amount of ATP.

The reaction that occurs in aerobic cellular respiration



The law of conservation of energy : Energy is transformed from one form to another without being created or destroyed.

The chemical energy stored in glucose (food) and oxygen is converted into energy stored **ATP molecules**.

cellular respiration is divided into 2 types

According to the availability of oxygen

1-Aerobic Respiration	2-Anaerobic respiration
This occurs under conditions where oxygen is available. Aerobic respiration is the most efficient for energy production, as it produces approximately 36 molecules of oxygen from one glucose molecule. from ATP	The cell switches to this process in the absence of oxygen. It is less efficient in producing energy, as it produces limited energy (only about two ATP molecules) with the formation of byproducts such as lactic acid in muscle cells, or alcohol in yeast.

For example, when do **hard exercise**, the **oxygen** available in the muscles for energy production **decreases**, so the cells temporarily resort to anaerobic respiration, which leads to the **accumulation of lactic acid in muscle** tissues and a **feeling of muscle fatigue**.

Reaction: Lactic acid fermentation



Reaction: Alcoholic fermentation



In cellular respiration processes: chemical reactions occur that result in the release of energy, and this type of chemical reaction is known as an **exothermic reaction**

Energy and chemical reactions

In a chemical reaction: bonds are broken in the molecules of the reactants and new bonds are formed in the molecules of the products.

This process involves:

- 1- **The consumption of energy** to break the chemical bonds between the reactant molecules.
- 2- **The release of energy** as a result of the formation of new bonds between the molecules of the products.

1- Exothermic reactions

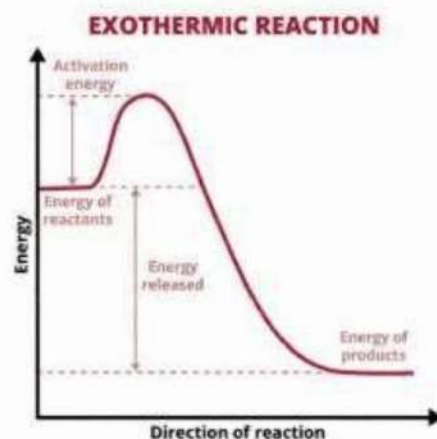
The product molecules have less stored energy (E_p) than the reactant molecules (E_R), **Its mean that** energy is released during these reactions.

This thermal energy is released into the surrounding environment, causing increase the surrounding temperature.

Example

When you add hydrochloric acid solution to sodium hydroxide solution (an alkali) in a glass flask, you will feel warmth or heat when you touch the container.

The reaction is an exothermic reaction,



2- Endothermic reactions

The product molecules have more stored energy (E_p) than the reactant molecules (E_R), **Its mean that** energy needs to be absorbed during these reactions.

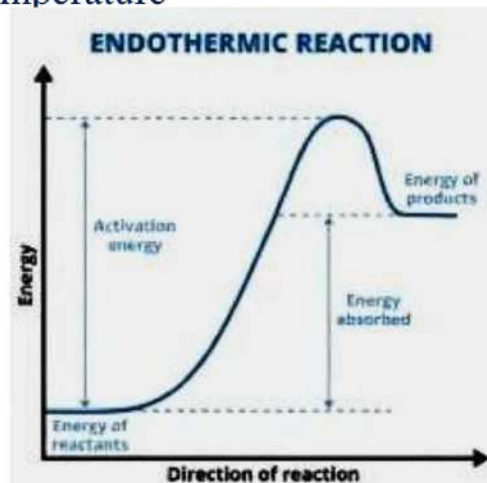
These reactions require large activation energy to occur.

This energy is obtained by the reactants through heating or from the surrounding environment, which decrease the temperature

Example

1- Photosynthesis in plants is an example of an endothermic reaction, where the plant absorbs light energy from the sun to convert carbon dioxide and water into glucose and oxygen.

2- The decomposition of solid potassium chlorate by heat into potassium chloride and oxygen gas.



Calculating the amount of heat released or absorbed during a reaction (heat change)

To know the amount of heat released or absorbed during the reaction, or the heat change (ΔH) associated with the reaction?

To calculate the heat change (ΔH) associated with a chemical reaction, follow these steps:

1- Verifying the law of conservation of mass in the reaction

A chemical reaction can be expressed by a symbolic chemical equation showing the reactants and products.

The chemical equation must be balanced to satisfy the law of conservation of mass (matter), which states that the sum of the masses of the reactants equals the sum of the masses of the products

Example: Water formation reaction



one molecule of oxygen reacts with two molecules of hydrogen to form two molecules of water.

Practically chemists express the amount of reactants and products in moles (mol)

A mole is a quantity of a substance whose mass in grams is equal to its molecular mass.

Example The mass of one mole of hydrogen (H_2) is 2g, its atomic mass is 1;

The mass of one mole of oxygen (O_2) is 32g, where its atomic mass is 16

mass of one mole of water (H_2O) is $18\text{g} = 16 + 1 \times 2 = 18$



In moles: We find that 2 moles of water are produced from the reaction of 1 mole of oxygen with 2 moles of hydrogen.

By gram : $4 \text{ gm} + 32 \text{ gm} = 36 \text{ gm}$

the total mass of the reactants equals the total mass of the products, despite the release of energy in the form of heat.

The law of conservation of mass, the mass is neither created nor destroyed during a chemical reaction, but rather transformed from one form to another. The presence of heat as a product does not imply a loss of mass, because heat represents energy, not matter, and therefore is not included in the calculation of mass.

2- Calculating heat content of products and reactants:

The heat content (H) of a substance is the amount of chemical energy stored in one mole of that substance, and its unit (kJ/mole)

The change in heat content (ΔH) is the difference between the total heat content of the products (H_P) and the total heat content of the reactants

$$\Delta H = H_P - H_R$$

1. If $H_R < H_P$, ΔH is positive, and the reaction is endothermic.

2. If $H_R > H_P$, ΔH is negative, and the reaction is exothermic. Example :

The equation illustrates the complete combustion reaction of a type of alcohol $2 \text{CH}_3\text{OH} + 3 \text{O}_2 \longrightarrow 4 \text{H}_2\text{O} + 2 \text{CO}_2$

$$\Delta H = -726.5 \text{ kJ/mol.}$$

1. Is this reaction endothermic or exothermic? Why?

2. Calculate the amount of heat released (in kJ) from the combustion of 80 g of methanol. Given that (C = 12, H = 1, O = 16)

Solution:

Since ΔH is negative, this means that the heat content of the products is less than the heat content of the reactants.

The difference between them is released to the surrounding environment, meaning the reaction is exothermic.

2. Calculate the amount of heat released from the combustion of 80g of methanol a- Calculate the molar mass of methanol

$$1- M(\text{CH}_3\text{OH}) = 12 + 3 \times 1 + 16 + 1 = 32 \text{ g.}$$

b- Calculate the number of moles n that corresponds to the given mass:

$$n(\text{CH}_3\text{OH}) = 80 \div 32 = 2.5 \text{ mol}$$

c- Calculate the amount of heat released from the combustion of 2.5 moles of CH_3OH

From the chemical equation:

$\therefore$ Burning 1 mole of methanol gives -726.5

kJ So Burning 2.5 moles of methanol gives

$$\Delta H = -726.5 \times 2.5 = -1816.25 \text{ kJ}$$



Chapter One (1) Lesson (2)

Choose the correct answer:

1-If blood viscosity increases so resistance to flow

a- increases b- decrease c- not change d-not sure

1-If blood viscosity decreases so resistance to flow

a- increases b- decrease c- not change d-not sure

3-Systolic pressure is a- 100 b- 120 c- 80 d-90 mmHg.

4-Diastolic pressure: a- 100 b- 120 c- 80 d-90 mmHg.

5-Blood density, which varies depending on the proportions of its components especially

a- blood b- Red b.c c- white b.c d-hemoglobin

6-Every cell in a living organism needs a constant supply of energy to

a-carry out its vital activities b-stop vital activities

c-not change d-decrease vital activities

7- Cellular Respiration

It is a series of chemical reactions that release the chemical energy stored in glucose and store it as usable energy in the form of

a-ATP b-ATM C-ATN d-AMP

8-The process begins in the cytoplasm with a stage known

a-ATP b-ATM C-ATN d-glycolysis

9- ATP then the breakdown products move to the mitochondria , which are the cell's a-

ATP b-ATM C-ATN d-powerhouses

10- The law of conservation ofis fulfilled in chemical reactions

a-energy b-charge c-mass d-momentum .

11- Aerobic Respiration: This occurs under conditions where oxygen is available. as it produces approximately.....molecules of oxygen from one glucose molecule. from ATP

a-36 b- 40 c-46 d-39

12- The cell switches to this process in the absence of oxygen is called

a- Anaerobic respiration b- Aerobic Respiration c-respiration d- not sure

13-Aerobic Respiration: it produces 36 molecules of oxygen from one glucose molecule. from

a-ATP b-ATB C-AFP d-PTB

14- It turns out that in cellular respiration processes, chemical reactions occur that result in the release of energy, and this type of chemical reaction is known..... reaction

a- exothermic b-Endothermic c-(a and b) d-no

15-In a chemical reaction, bonds are.....

a-broken b-formed c- (a,b) d-no change in the molecules of the reactants

16-HCl (aq) + NaOH(aq) $\longrightarrow$ H₂O(l) + NaCl(aq) + E is called

a-Endothermic R b-Exothermic R c-not R d-not sure

a- kJmole b- kJ/mole c- kJ d- mole/J

a) Cohesion and adhesion only b) Cohesion, adhesion, and tensile forces resulting from transpiration c) Active energy transport
d) Tensile forces resulting from transpiration only

- a) Storing organic materials
- b) Giving cells flexibility and elasticity
- c) Resisting tensile pressure during water ascent
- d) Regulating stomatal openings

A) Transport of oxygen across the cell membrane
B) Osmosis of water
C) Transport of ions from a lower to a higher concentration in root cells
D) Diffusion of gases from the lungs to the blood

- a) They occur in one direction
- b) They aim to distribute materials and energy within the body
- c) They depend on lignin
- d) They depend on transpiration

A) capillaries B) arteries C) veins D) heart

a) Carbon dioxide, water, and energy
b) Alcohol and energy
c) Lactic acid only
d) Energy without other products

a) Photosynthesis b) Aerobic respiration c) Protein synthesis d) Lipid storage

b) Water only b) Ethanol or lactic acid
c) Carbon dioxide only d) Additional glucose

A) Glucose synthesis in photosynthesis B) Glucose breakdown in aerobic respiration C) Formation of glucose molecules

27- The relationship between respiration and photosynthesis is that:

- a) The products of respiration are reactants in photosynthesis
- b) Both take place in the mitochondria
- c) Both require sunlight
- d) Both occur in all living organisms

Essay questions

- 1- Explain Blood viscosity controls its flow rate.
- 2- Explain Blood density, which varies depending on the proportions of its components (especially hemoglobin).
- 3- Explain :ATP then the breakdown products move to the mitochondria
- 4- Write The reaction that occurs in aerobic cellular respiration can be expressed by the following chemical equation.
- 5- Write Reaction of Lactic acid fermentation ?
- 6- Write Reaction: Alcoholic fermentation
- 5- The mass of one mole of hydrogen (H_2) is 2g, where its atomic mass is 1; the mass of one mole of oxygen (O_2) is 32g, Find atomic mass of water ?
- 6- Explain the following:
Why does water rise in plants despite the absence of an internal pump?
- 7- Explain Why do plants have two types of vascular tissue (xylem and phloem)?
- 8- Explain Why is aerobic cellular respiration more efficient at producing energy than anaerobic respiration?
- 10- Explain Why is cellular respiration an exothermic reaction?

Model answer

- 1- a 2- b 3- b 4- c 5- d 6- a 7- a 8- d 9- d 10- d 11- a 12- a
13- a 14- a 15- a 16- a 17- b

Essay questions

- 1- **Blood viscosity controls its flow rate.** 1- If blood viscosity increases (as in cases of dehydration or an increased number of red blood cells), 2- resistance to flow increases, causing high blood pressure. Conversely, 3- if viscosity decreases, 4- blood flows more easily, and blood pressure decreases.
- 2- **Blood density, which varies depending on the proportions of its components (especially hemoglobin), affects the effort required to pump blood.** In addition to blood properties, the elasticity of blood vessel walls during contraction and relaxation, and the force of the heart is pumping action, also influence this vital pressure.
- 3- **ATP then the breakdown products move to the mitochondria, which are the cell's "powerhouses," where aerobic respiration takes place in the presence of oxygen, producing carbon dioxide, water, and a large amount of carbon dioxide molecules.**
- 4- $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + E$
- 5- **Reaction: Lactic acid fermentation**
 $C_6H_{12}O_6 \longrightarrow 2C_3H_6O_3 + 2ATP$
- 6- **Reaction: Alcoholic fermentation**
 $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + 2ATP$
- 7- mass of one mole of water (H_2O) is $18\text{ g} = 16 + 1 \times 2$



Lesson Three

Metabolic Wastes and Excretory Organs and its role in balance of energy

Human body cells perform a huge number of precise biochemical reactions continuously.

These reactions enable the body to perform its various functions, such as: obtaining energy from food, building necessary biological molecules, resisting infections, and replacing damaged cells. (metabolic processes)

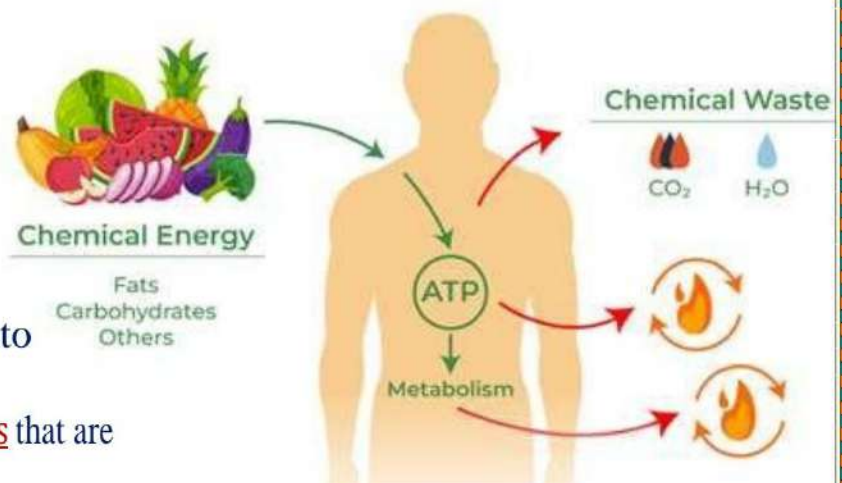
Metabolism includes

Anabolism, where new materials needed by the body are produced,
Catabolism, where complex molecules are broken down to obtain energy.
Metabolic reactions are essential for life, but they do not always produce useful materials.

Metabolic wastes Many of bi-products that the body does not need but leave them behind, and can be harmful if they accumulate.

Bi-products include

- 1- Carbon dioxide produced by cellular respiration,
- 2- Ammonia produced by the breakdown of amino acids in the liver,
- 3- Urea that results from converting toxic ammonia into a less harmful form,
- 4- Excess water and mineral salts that are excreted in various ways.



[- Metabolic Wastes]

The organism needs a precise mechanism to get rid of Metabolic Wastes (G.R.?).

Because the accumulation of these wastes leads to disruption of the chemical balance of fluids inside the body, and affects the efficiency of cell function, Excretion process is the biological process through which metabolic wastes are removed from the body, and maintain the internal environment of the body

(Homeostasis)

The kidneys regulate the concentration of water and ions in the blood,
The skin secretes water and salts through sweat glands to help regulate body temperature,
The lungs expel carbon dioxide and water vapor to the atmosphere,
The liver is a major center for waste processing, as it converts toxic substances into compounds that can be safely excreted.

Water and Salt Balance inside the Body

The kidneys are among the most important organs of the excretory system,

The Function of kidneys

1- Purify the blood from liquid wastes resulting from vital reactions inside the body.

They produce urine, which is the liquid produced to get rid of excess water, excess salts, urea, and some other dissolved wastes.

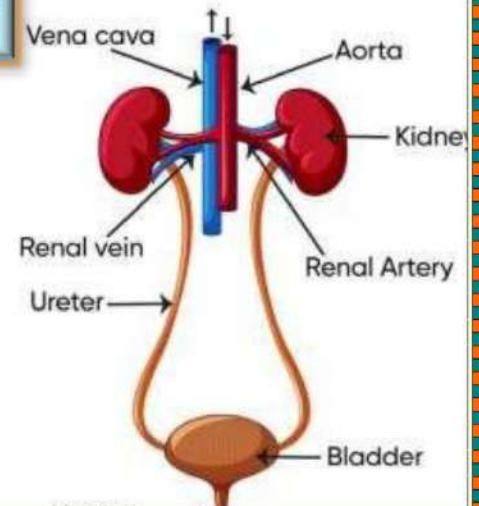
The size of one kidney is approximately the size of a fist, and its shape resembles a bean,

Location located on the two side of the vertebral column in the lower back.

Urine is formed from filtration of blood inside nephrons (tiny units), where wastes are removed from the blood,

Reabsorption process Useful materials such as glucose, ions, and water are returned to the extent needed by the body, to maintain internal balance.

After urine is produced, it moves through the ureters to the urinary bladder, where it is stored until it is expelled outside the body through the urethra.



[Diagram of the Urinary System]

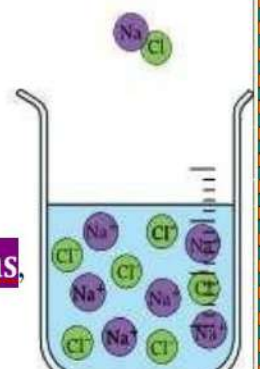
Water and Salt Balance inside the Body

Importance of sodium, potassium, and chloride ions

- 1- Essential for the function of nerves and muscles,
- 2- Regulating osmotic pressure inside and outside cells.

What happens when a disturbance occurs in the concentration of these ions.

Biological processes are affected. So, the excretory system - especially the kidneys - regulates this balance with extreme precision.



[Concentration of Sodium and chloride ions]

What happen when?

The concentration of sodium in the blood increases.

The kidneys retain water to dilute its concentration,

The concentration of sodium in the blood decreases.

The kidneys get rid more water is to maintain ionic balance in the body.

Excretion contributes to maintaining the balance between ions and water in body fluids, keeping the internal environment stable.

Reabsorption

It is the process of returning useful materials from the fluid that has been filtered in the nephron back to the blood.

This occurs in each nephron, where useful materials pass through the walls of the surrounding cells to the tiny blood vessels.

During Reabsorption process:

- Most of the glucose is reabsorbed into the

blood to provide energy for the cells.

- A large amount of water is reabsorbed to maintain blood volume and fluid balance in the body.

- Important ions such as sodium, potassium, and chloride are also reabsorbed to regulate muscle and nerve functions and maintain blood pressure.

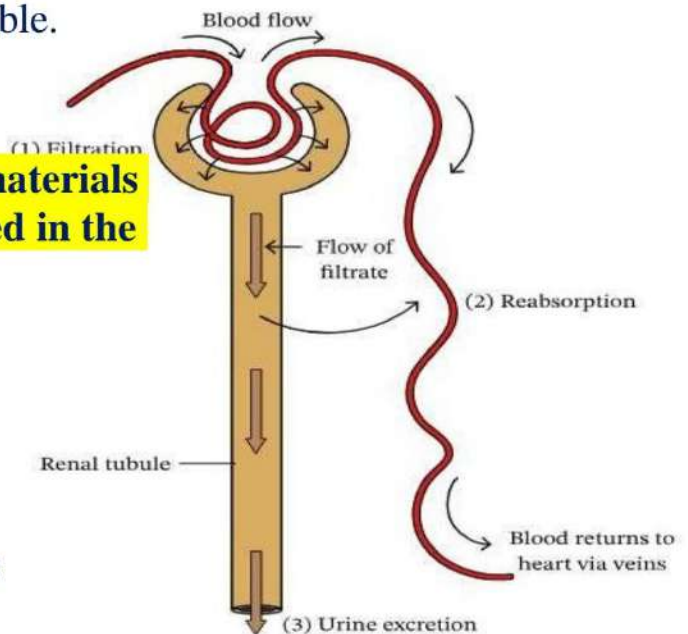
- The materials that the body does not need, such as urea, excess water, and some ions, they are left to be excreted later with urine.

Importance of Reabsorption

1- Maintaining internal balance (homeostasis) in the body,

2- It enables it to control what it retains and what it gets rid of.

Without reabsorption, the body would lose large amounts of water and nutrients, leading to severe dehydration, salt disturbance, low blood pressure, and possibly cessation of vital organ functions.



[Simple diagram of a nephron showing the steps of urine production]

The Skin and Its Role in Excretion and Temperature

The skin has a dual role (protection - excretion.)

The skin contains:

Sweat glands: secrete sweat, [water, mineral salts (NaCl) and small amounts of urea]

Importance of Sweat

1- Regulate body temperature when sweat evaporates from the skin surface, keeping the body at constant temperature.

2- Maintains the balance of fluids and ions inside the body.

By getting rid of water, salts, and a very small percentage of urea with sweat

The skin Structure skin consists of three main layers:

- Epidermis: The outer layer that protects the body from microbes and water loss.
- Dermis: Contains sweat glands, hair follicles, and blood vessels that regulate temperature.
- Subcutaneous layer: Rich in fats that act as a thermal insulator.

The integration of the skin with the kidneys in excreting excess water and ions is a wonderful example of the integration of excretory organs in maintaining internal balance.

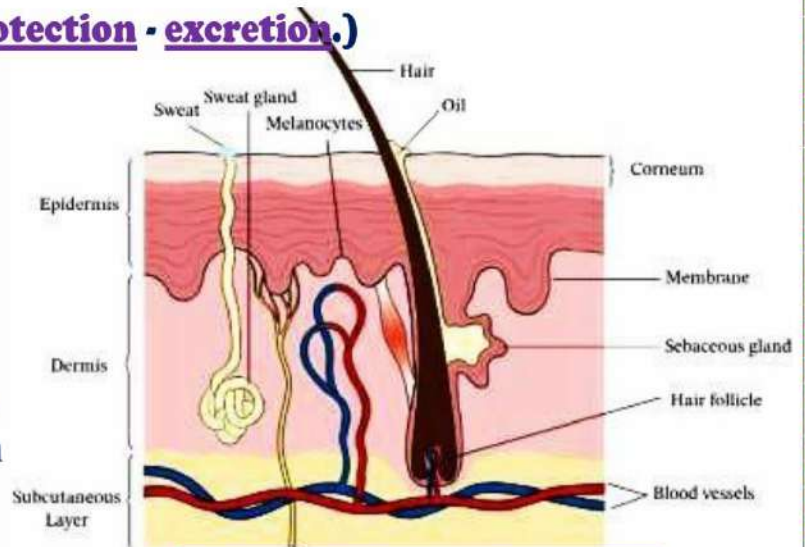


Diagram of Human Skin]

The Liver and its role in waste processing

[Diagram showing the liver and gallbladder]

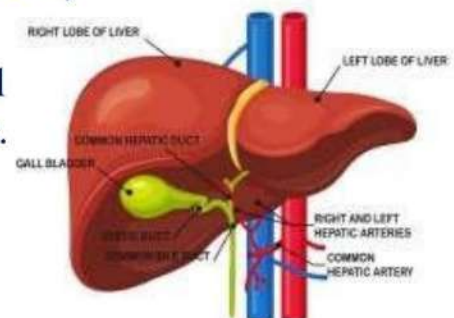
The liver is most important organ in the excretion process,

The liver function:

1- The liver works to purify the blood from harmful substances and wastes resulting from vital reactions.

2- The liver maintains the balance of the body's internal environment by converting toxic substances into safe compounds that the body can easily get rid of.

3- The liver acts as a purification center or "treatment station" that protects the body from the accumulation of toxins.



4-The liver helps protect the body from the accumulation of harmful substances in multiple ways :

1- It converts toxic ammonia into the less harmful urea which is transferred to the kidneys and excreted with urine.

2- Break down hemoglobin resulting from the breakdown of old red blood cells, producing bilirubin, which is secreted in bile and excreted with feces, while its accumulation leads to jaundice

3-The liver also removes toxins and foreign substances such as drugs and food additives by converting them into less harmful substances before getting rid of them.

4- Bile helps get rid of some water-insoluble wastes such as excess cholesterol and some pigments, contributing to maintaining the internal balance of the body.

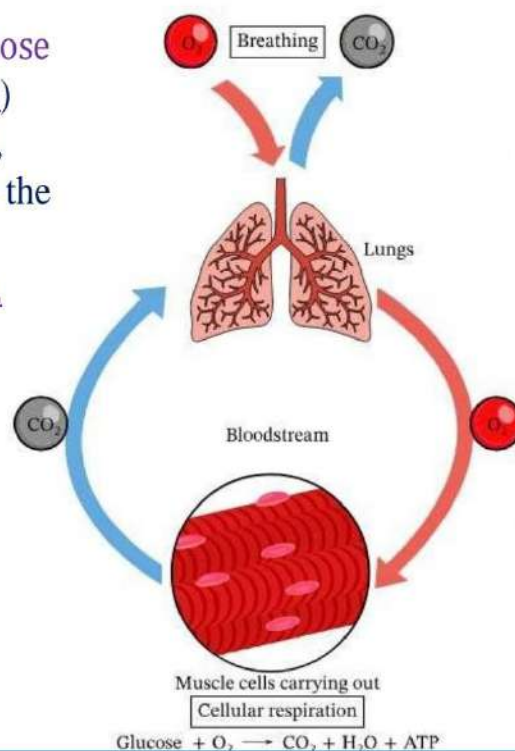
The role of the lungs in excreting gaseous wastes

In cellular respiration, body cells use oxygen and glucose to produce energy, resulting (water and carbon dioxide) Carbon dioxide moves from the cells to the blood, which carries it to the lungs to be expelled outside the body with exhaled air.

The exhalation process is part of the excretion process, as it rids the body of gaseous wastes.

The accumulation of carbon dioxide gas in the blood increases the acidity of the blood, which disrupts the work of enzymes and threatens vital processes.

Regular breathing is necessary to maintain the balance of gases in the blood, and thus the internal balance of the body.



[The role of the lungs in excretion]

Technological Applications

The Bio-artificial Kidney

The bio-artificial kidney (renal simulation devices).

Its function modern technological applications for treating kidney failure

This kidney works inside the patient's body or is implanted in it, and aims to perform the functions of a natural kidney.

The basic physical principle in its operation is filtration,



[Artificial Kidney]

Filtration blood fluid passes through fine semi-permeable membranes that

1- Allow small molecules and wastes to pass to a cleaning fluid or to the other side of the membrane,

2- Preventing the passage of proteins and large blood cells

As for the biological aspect, it relies on cell engineering;

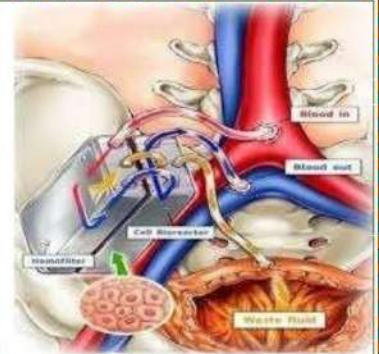
The bio-artificial kidney contains **specialized cells** (taken or laboratory engineered) that **do same of the biochemical functions of the kidney**, such as adjusting the levels of certain salts and secreting important compounds.

With the presence of these cells along-side the filtration units, more precise monitoring of the balance of substances in the blood is achieved.

Physics of Ultrasound in the Kidneys and Bladder:

Ultrasound devices (high-frequency) are used to picturing excretory organs and diagnose stones or infections.

They depend on the properties of sound waves such as reflection and refraction to form an accurate image of the condition of internal organs without the need for surgical intervention.



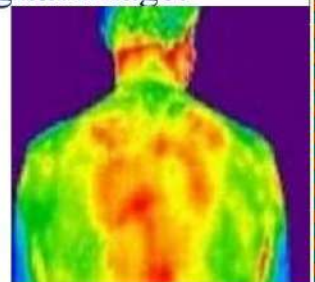
• **Wave reflection:** Ultrasound waves collide with the boundaries between different tissues (such as the bladder wall or the surface of a stone), and part of them bounces back. The strength of bounce depends on the acoustic resistance of the tissue.

• **Wave scattering:** Occurs when waves collide with irregular surfaces or small particles inside tissues, helping to show details of the organ's texture.

• **Digital processing:** The device calculates the time taken for the echo to return, and through the speed of sound in tissues, determines the depth and location of the organ with precision and converts it into a digital image.

Thermal Physics and the Function of Sweat Glands:

The sweating process depends on absorbing an amount of body heat to evaporate sweat, (thermal balance and evaporation.) **Infrared thermography devices** are used to analyze the rate of heat loss through the skin, helping to monitor the internal thermal balance of the body.



Element cycles in the biosphere

Excretion process contributes in maintaining internal balance inside living organisms.

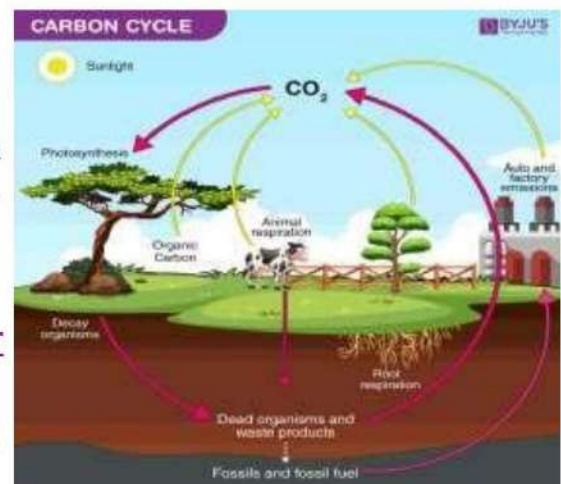
This balance extends to include all ecosystem.

The body's organs work together to maintain its internal balance, the elements of the biosphere - such as water, carbon, and nitrogen - work in continuous natural cycles that ensure the continuation of life on Earth.

Among the most important of these elements: carbon, nitrogen, and phosphorus, which enter into successive cycles where they move between air, water, soil, and living organisms.

Carbon Cycle

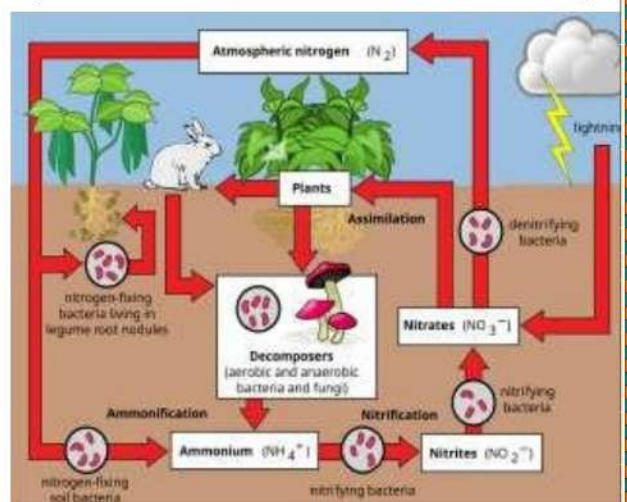
Green plants absorb carbon dioxide gas from the air during the process of photosynthesis to produce food, and then carbon-containing compounds move to animals when they feed on plants. When living organisms breathe or decompose, carbon dioxide gas returns to the air again. In addition to carbon oxides emitted from factories and fuel combustion.



Nitrogen Cycle

Nitrogen represents a basic component of proteins inside the bodies of organisms.

The nitrogen cycle begins with the fixation of atmospheric nitrogen by a type of bacteria present in the soil, converting it into compounds that can be absorbed by plants.



These compounds move to animals through food, and then return to the soil again through waste or dead organisms, where types of bacteria reconvert them to nitrogen gas that returns to the atmosphere.



Phosphorus Cycle:

Phosphorus compounds are found in rocks and soil.

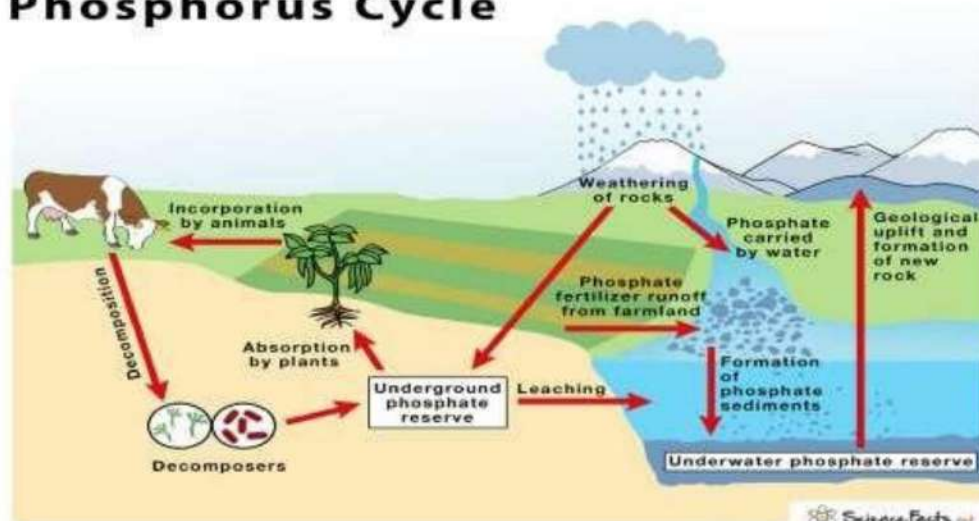
The plant absorbs phosphorus compounds after they are released from rocks as a result of weathering processes, and then moves to animals through the food chain to form bones, teeth, nucleic acids (DNA and RNA), and energy molecules (ATP).

When living organisms die or through their waste, decomposers return phosphorus to the soil again.

Unlike the carbon and nitrogen cycles, the atmosphere is not part of the phosphorus cycle, but the phosphorus cycle remains confined between the biosphere, lithosphere, and hydrosphere.

Element cycles are essential for the continuation of life on Earth, as they ensure the recycling of vital elements between living organisms and the environment in a balanced manner.

Phosphorus Cycle



The excretion process is not limited to getting rid of wastes from inside living organisms,

But represents an important link in the continuation of element cycles in nature.

The materials resulting from excretion, such as carbon dioxide and urea, return to participate in the cycles of carbon, nitrogen, and others; where urea decomposes in the soil by bacteria into ammonia and then nitrates, which are absorbed by plants, ensuring the reuse of elements and the continuation of life in the biosphere.

Excretion processes and natural cycles together contribute to maintaining balance and stability in the biosphere, keeping it suitable for supporting different forms of life.

Chapter three (3) Lesson

Choose the correct answer

1- Which of the following organs is the main one responsible for removing nitrogenous wastes from the blood?

- a) Liver b) Skin c) Kidneys d) Lungs

2- When salts increase in the blood, the kidneys respond by:

- a) Secreting more sweat b) Increasing water reabsorption
c) Increasing water excretion d) Storing salts

3- Toxic ammonia in the body is converted to urea in the:

- a) Kidneys b) Liver c) Lungs d) Skin

4- What illustrates the relationship between excretion and internal balance in the body?

- a) Excreting water only b) Maintaining the stability of the body's internal environment
c) Producing energy d) Transporting oxygen

5- If the kidneys fail to perform their functions, the first thing affected is:

- a) Oxygen level b) Percentage of wastes in the blood
c) Number of blood cells d) Hormone production

6- The amount of sweat secreted by the body increases when:

- a) Temperature decreases b) Humidity increases
c) Temperature rises d) Blood flow to the skin decreases

7- What component is reabsorbed in the kidneys to maintain water balance?

- a) Glucose b) Carbon dioxide c) Water d) Ammonia

8- Excretion of carbon dioxide from the lungs is an example of:

- a) Temperature regulation b) Gaseous excretion
c) Solid excretion d) Neural transport

9- What is the common role of the skin and kidneys in homeostasis?

- A) Hormone production B) Waste storage
C) Water and salt excretion D) Energy production

10. Body toxicity increases when

- (A) the respiratory rate decreases B) metabolic waste accumulates
C) sweating increases D) blood pressure decreases

II. Essay Questions

Explain:

1- Ammonia in the body is converted to urea before excretion?

2- Excreting a large amount of sweat in hot weather helps keep the body balanced?

3- A disturbance in body functions occurs when metabolic wastes accumulate?

4- The amount of urine increases when drinking large amounts of water?

5- Excretion is essential for maintaining the homeostasis of a living organism?

Lesson Four

Sensation and Response

and Their Role in the Interaction of Living Organisms

Sensation of stimuli and responding to them are fundamental characteristics that distinguish living organisms.

Sensation enable organisms to interact with their environment and maintain survival.

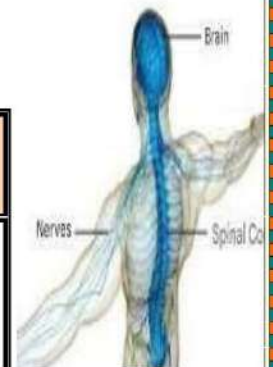
The nervous system is the system responsible for receiving information from the surrounding environment, processing it, and then issuing appropriate responses through a precise mechanism that allows the organism to adapt to environmental changes.

This contributes to the stability and balance of the biosphere, as each organism maintains its internal balance and responds appropriately to external factors.

The Nervous System

The nervous system consists of:

The central nervous system	The peripheral nervous system
<u>Brain and spinal cord</u>	all <u>nerves</u> spread throughout the body <u>connecting the central nervous</u> system to the <u>rest of the organs</u> .



The function of nervous system receives signals from the senses, processes them, and then sends Orders to other parts of the body for appropriate responses, whether voluntary or involuntary.

Nerve Cell: is the Unit of Interaction with the Environment

Nerve cells are the basic building unit of the nervous system.

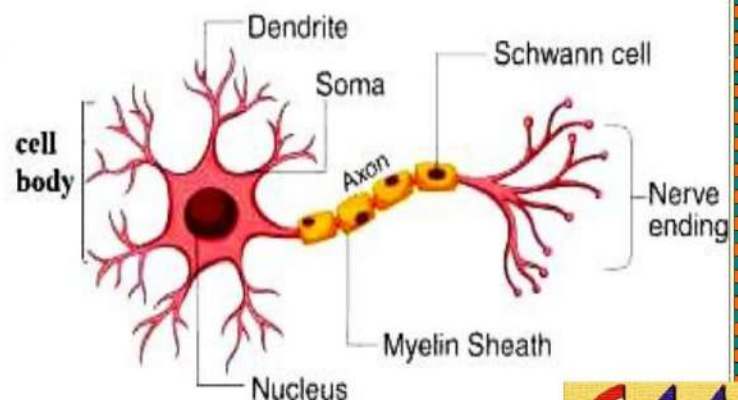
Each neuron typically consists of:

1-A cell body:- containing the nucleus and organelles.

2-Dendrites:- that receive signals.

3-An axon:- that transmits signals away from the cell body toward other cells, muscles, or glands.

4-Axon terminals:- that communicate with other cells through synapses.



Types of neurons

Sensory neurons	Motor neurons	Interneurons (relay neurons)
transmit information from sensory receptors to the central nervous system	transmit commands to response organs such as muscles and glands	connect sensory neurons to motor neurons

Nerve impulse and membrane potential

Ion distribution differs inside and outside the neuron:

Sodium ions (Na^+) are more concentrated outside.

Potassium ions (K^+) are more concentrated inside.

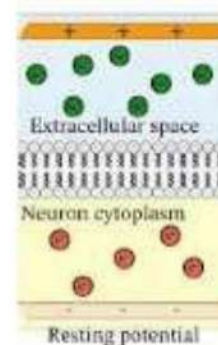
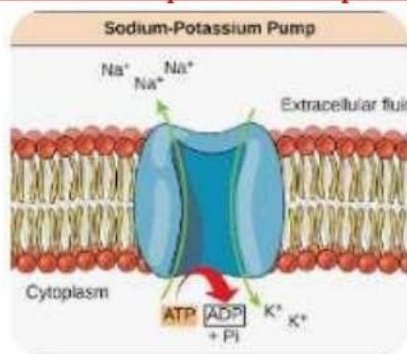
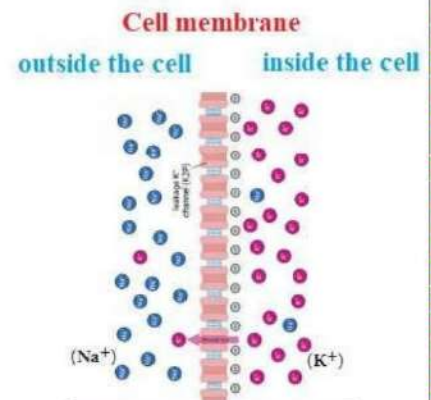
This creates a Potential difference across the membrane called the membrane potential.

1- At rest, (polarization) the outside of the membrane is positive and the inside is negative (about -70 mV). Result from three mechanisms

A-Selective permeability of the cell membrane, which allows (K^+ exits more easily than Na^+ enters). ions into the cell

B-Unequal ion distribution (the concentration of negative ions and proteins inside the cell is higher than outside. There are negative ions of chloride and some proteins.

C-Sodium-potassium pumps (use ATP molecule expels 3 Na^+ and brings in 2 K^+).



2- Changes in the nerve cell on stimulation (depolarization)

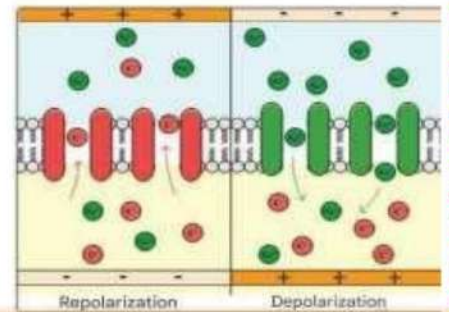
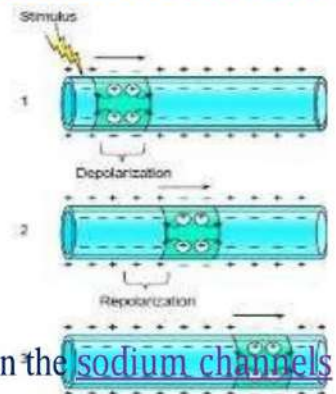
When a nerve cell receives a stimulus sufficient to excite it, special channels in the nerve cell membrane open, allowing sodium ions (Na^+) to move at a rapid rate, making the potential inside the cell positive. The potential difference across the cell membrane becomes (about $+40$ mV). known as depolarization.

3- Propagation of nerve impulse

Depolarization acts as a stimulus to the adjacent region of the nerve, causing changes very similar to those that occurred when the nerve cell was first stimulated, and so on. A nerve impulse travels along the nerve cell in the form of pulses, from depolarization, then repolarization, then depolarization, and so on.

The first region of the membrane experiences repolarization when the sodium channels close and the potassium channels open for the release of potassium, returning the potential difference to its previous negative value.

4- Refractory period: short period (about 0.001-0.003 seconds), the cell does not respond to a new stimulus, after which it regains its readiness to respond to a new stimulus.



Synaptic Transmission: The Chemistry of Neural Communication

How does this impulse travel from one neuron to another?

At the end of the axon of a neuron, the nerve signal does not travel directly to the next neuron. it passes through a connection called a synapse.

Each neuron connects to a vast number of other neurons through these synapses.

To imagine the complexity of this system,

Single Purkinje cell, a type of neuron found in the brain, can receive signals from approximately 200,000 synapses simultaneously, from different neurons converging to determine a single, coordinated response.



The synaptic cleft consists of three parts:

1- The presynaptic membrane: a bulge at the end of the axon of the cell transmitting the nerve impulse. Small sacs called neuro vesicles are found inside the synaptic clefts, containing chemicals important in nerve impulse transmission, such as **acetylcholine and noradrenaline**.

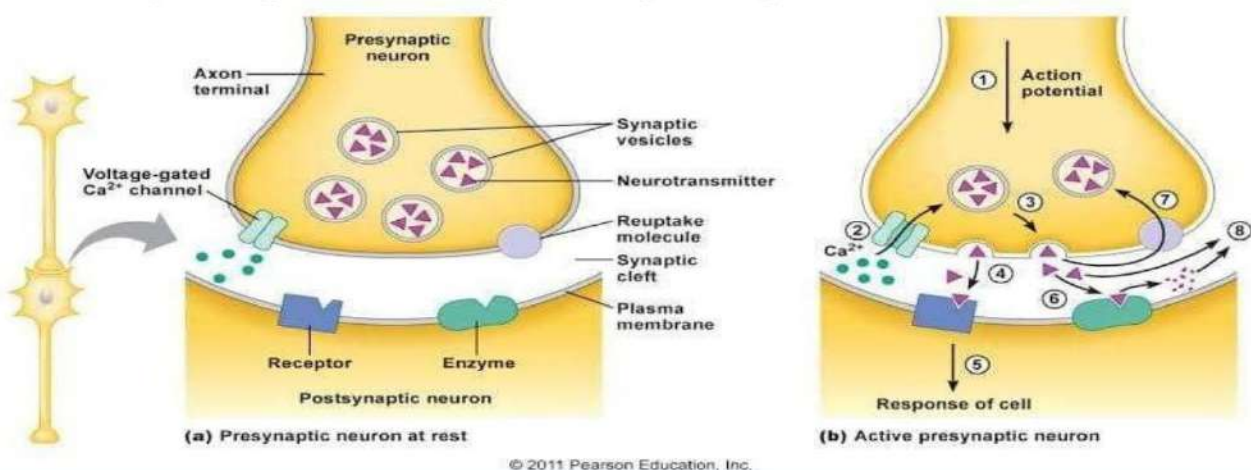
2- The synaptic cleft: a tiny space between two adjacent cells.

3- The postsynaptic membrane: part of the receiving cell membrane.

Inside the synaptic cleft are small vesicles containing neurotransmitters such as acetylcholine and noradrenaline, chemicals that transmit the signal between cells.

Mechanism of Impulse Transmission Across the Synaptic Cleft

1. When the nerve impulse reaches the axon end, a number of channels open, allowing calcium ions (Ca^{2+}) to pass into the synaptic cleft.
 - 2- The interring of (Ca^{2+}) ions lead the release of neurotransmitters into the synaptic cleft
 - 3- The carriers diffuse across the cleft and bind to specific receptors on the next cell, opening sodium and potassium ion channels in its membrane and generating a new nerve signal.
 - 4- After neurotransmitters acetylcholine have done their job, then they are broken down by special enzymes and the cell membrane returns to its resting state.
- In this way, the nerve impulse travels through the nervous system with high accuracy and speed, enabling the body to respond to stimuli.



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Technological Applications Nerve Conduction Velocity Test (NCV)

A diagnostic procedure used to assess nerve function and integrity. It helps evaluate nerve damage, detect related disorders, and determine the extent and location of injuries or abnormalities. It is often used to diagnose and evaluate conditions affecting the nerves and spinal cord.

During the test, small electrical currents are passed over specific nerves using surface electrodes placed on the skin. These electrical impulses stimulate the nerves, and the resulting responses are recorded and analyzed. The test is generally safe and non-invasive.



Sodium and Potassium



Leading the positive potential within the cell

What is the primary function of neurotransmitters in the synapse?

- (a) **Energy storage**
- (b) **Signal transmission between two cells**
- (c) **Ion breakdown**
- (d) **Increasing axon speed**

Which of the following occurs immediately after the nerve impulse reaches the terminal switches?

- (a) **Calcium exits the cell**
- (b) **Calcium enters and vesicles fuse with the membrane**
- (c) **Sodium channels close**
- (d) **Neurotransmitter breakdown**

Cholinesterase enzyme works to:

- (a) **Stimulate depolarization**
- (b) **Rebuild vesicles**
- (c) **Break down acetylcholine after it has performed its function**
- (d) **Increase membrane permeability**



- (a) Prevents the cell's response
- (b) Keeps the membrane ready to transmit the impulse when a stimulus occurs

- (c) Increases the number of synapses
- (d) Reduces the membrane's permeability to water

11- A Purkinje cell, which can receive hundreds of thousands of synapses, shows that

- (a) The nervous system is slow to respond
- (b) Neurons operate independently
- (c) The nervous system is an interconnected network that transmits information quickly and accurately

II. Essay Questions

Explain

1. The sodium-potassium pump is essential for maintaining the resting potential in neurons.
- 2- Hyperpolarization occurs immediately after repolarization.
- 3- The presence of a synaptic cleft between two neurons is necessary, although it is very small.
- 4- The nervous system operates faster than the hormonal system.
5. Inhibition of the sodium-potassium pump by opioid venom (snake venom) leads to the shutdown of the nerve system.



Lesson five Nanotechnology Applications and Biosphere Sustainability

Humans have been able to observe what is smaller than cells and to control the structure of matter at the molecular and atomic level. Thus, nanotechnology techniques emerged, which have revolutionized human interaction with the biosphere.

One of the real challenges facing doctors and scientists is how to deal with a cancerous tumor in a patient's body without destroying healthy cells and tissues?

For many years, traditional cancer treatments - whether chemical or radiation - were a double-edged sword; they kill cancer cells but cause severe side effects to the entire body. The field of nanotechnology developed and offered an exciting solution, where the cancer drug was surrounded by targeted nanoparticles that aim only at cancer cells, where they release the drug directly there and reduce the chances of exposure of other tissues to the toxic drug substance. This led to increased treatment effectiveness and reduced side effects. This advancement opens the door to many other applications in medicine, energy, and the environment, and constitutes an appropriate entry point to study what we mean by nanomaterials and why they possess this power.

What is Nanotechnology?

The word nanotechnology consists of two parts:

Nano: A Greek word meaning "dwarf" - something extremely small.

Technology: Meaning the practical application of knowledge in a specific field.

Nanotechnology is the technology of dealing with materials in extremely small dimensions **measured in nanometers** to produce new materials and devices that possess unique properties not found in their normal state.



What is the Nanoscale?

Nano is a very small unit of measurement, equal to one part of a billion parts of a meter ($1\text{nm} = 10^{-9}\text{m}$), meaning one nanometer is smaller than the diameter of a human hair by about a hundred thousand times!

Nanomaterials are materials where at least one of their dimensions ranges between 1-100 nm.

Nanoscale gives them different properties compared to their larger counter parts.

Why do materials properties change at the Nanoscale?

When a material shrinks to small size, its chemical and physical properties change, such as color, hardness, solubility, electrical conductivity, and even melting point.

Due to two main factors:

Increased surface area to volume ratio:

Imagine you have a large sugar cube and another one broken into small granules. **Which dissolves faster in water?**

The broken sugar, because its surface area is larger (which increases the chances of contact and collision between water molecules and sugar).

Nanomaterials: the smaller particles (is larger in their active surface area compared to their volume and the greater their ability to react.

Quantum Effects:

Quantum effects appear when the dimensions of the particle approach the wavelengths associated with the movement of electrons, making the material behave in completely new ways.



- **Examples of nanomaterials:**

- **Nano gold:** Gold in its normal state is yellow and shiny, but when reshaped on the nanoscale, its color changes according to the size of the particles, so it may become red, orange, or blue!
- **Nano copper:** When copper particles are reduced to the nanoscale, their hardness and strength increase compared to ordinary copper.

Nanochemistry

It is the branch that studies how to manufacture, describe, and apply nanomaterials and is concerned with understanding the changes in properties at this small scale.

Nanomaterials come in different forms depending on their dimensions:

Zero-dimensional nanomaterials (0D Nanomaterials): In this type, all dimensions of the material (length, width, height) are within the nanoscale. These materials appear as points or very fine granules. **Examples:** Quantum dots, nanoparticles (like gold or silver nanoparticles).

One-dimensional nanomaterials (1D Nanomaterials): These materials have only one dimension outside the nanoscale (i.e., their length may be large), while the other two dimensions are in the nanoscale.

Examples: Nanotubes (like carbon nanotubes), nanofibers and nanowires.

Two-dimensional nanomaterials (2D Nanomaterials): These materials have two dimensions outside the nanoscale (a large flat area), while only their thickness is in the nanoscale. They usually appear as very thin sheets or layers.

Examples: Graphene, thin films, and nanolayers.

Three-dimensional nanomaterials (3D Nanomaterials): These are materials where none of their dimensions are in the nanoscale (they are large in all there dimensions),



but they consist of nanoscale building units or have an internal nanostructure (such as pores or embedded granules).

Examples: Nanoporous materials, polycrystalline nanomaterials and nanocomposites.

Neural conduction using nanomaterials

We learned that nerve impulses travel through nerve cells in the form of electrical pulses that move from one cell to another through the neural synapse, allowing the body to respond quickly to different stimuli.

But what happens if part of this neural pathway is damaged? Can the nerve impulse cross the damaged area?

Nanoscience has enabled scientists to invent new ways to reconnect damaged nerves and help the nerve impulse pass again as if the nerve had not been damaged.

Electrically conductive nanomaterials such as carbon nanotubes and nanowires are used in this field, where these materials work to transmit nerve signals between damaged nerve cells, just as nerve impulses travel in a healthy nerve.

When carbon nanotubes or nanowires are placed between the ends of a severed nerve, these parts form a nanobridge that allows the passage of electrical nerve impulses from one end to the other, helping to gradually restore movement or sensation.

Neural nanotech interfaces are also used to record nerve signals and send them to external devices, such as smart artificial limbs.

The field of nanotechnology integrates to enhance the flow of nerve impulses even in cases of nerve damage.



Scientists are using **Nano chips implanted in the brain** to help paralyzed patients move their limbs or communicate through devices just by thinking, as the chip picks up nerve impulses and sends them to a computer or artificial arm that moves according to the nerve command.

Biofuel Cells and Nano Applications

Biofuel cells work in a way similar to what cells do in cellular respiration

In both: glucose is oxidized (loses electrons) to obtain energy.

The difference is that biofuel cells do not produce ATP, but directly convert chemical energy into electrical energy that can be used to operate devices.

Biofuel cells work as sustainable batteries, where enzymes are used at the negative pole (anode) to oxidize glucose, leading to the release of electrons and protons. **Carbon nanotubes that increase the efficiency of transferring these electrons**, they flow through an external electrical circuit (generating a current) toward the positive pole (cathode) - just as electrons move in wires to light a lamp.

The role of nanotechnology is in increasing the efficiency of this process. Nanoparticles such as nano gold or carbon nanotubes are used to cover the poles inside the cell, where they work as electrical catalysts that accelerate reactions and facilitate the transfer of electrons, just as enzymes inside mitochondria accelerate cellular respiration reactions.



Biofuel cells are a wonderful example of imitating biological processes in technology, where scientists were inspired by the idea of energy production from inside living cells to design devices that generate clean and safe energy, which can operate medical devices implanted in the body using glucose present in the blood as an energy source.

Research Activity

Investigate how nanomaterials can be used to improve human life without harming the biosphere.

Research a medical or environmental product that relies on nanotechnology.

Identify the nanomaterial used and its function.

Discuss in your group: Does this technology have side effects on living organisms or the environment?

Suggest modifications or more sustainable uses.

Present your results in a scientific poster that illustrates the relationship between nanotechnology and balance in the biosphere.

Choose the correct answer:

The properties of a material at the nanoscale differ from its properties in the normal state because of:

- a) Mass deficiency
- b) Increased surface area relative to volume
- c) Change in atomic structure
- d) Decrease in material temperature

When reducing the size of gold to the nanoscale, its color changes because:

- a) The number of electrons in its atoms decreases
- b) Its interaction with light changes
- c) Its density increases
- d) It loses its metallic properties

The hardness of copper increases at the nanoscale as a result of:

- a) Increase in the number of electrons in its atoms
- b) Proximity of molecules
- c) Increased surface area to volume ratio
- d) Increase in nuclear energy in its atoms



Carbon nanotubes are used in electronics because they:

- a) Are electrically insulating
- b) Conduct electricity better than copper
- c) Decompose quickly
- d) Dissolve in water

The work of biofuel cells resembles the process of cellular respiration in that both:

- a) Produce energy from oxidation of glucose
- b) Consume ATP molecules
- c) Store energy
- d) Depend on sunlight for their operation

Nanoparticles are used in biofuel cells because they:

- a) Reduce reaction rates
- b) Increase the rate of electron transfer
- c) Prevent oxidation of reactants
- d) Inhibit enzyme function

In drug delivery using nanotechnology, nanoparticles help:

- a) Distribute the drug throughout the body
- b) Increase the drug dose
- c) Deliver the drug directly to infected cells
- d) Prevent its absorption

Second: Essay Questions

Explain :

Materials show new properties when they reach nanoscale dimensions less than 100 nanometers?

Biofuel cells are considered a vital application of clean energy?

The activity of chemical reactions increases in nanoparticles compared to the normal size of the material?

Carbon nanotubes are used in designing future space elevators?

Nanotechnology is considered a bridge between biology, physics and chemistry to serve environmental sustainability

